Title*

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Abstract

The life-cycle hypothesis suggests that older workers partially retire as they transition from full-time work toward full retirement. However, few people participate in partial retirement schemes. Drawing on administrative data of all clients of the largest pension fund in the Netherlands, we explain partial retirement behavior using two pension reforms and a dynamic life-cycle model. We use one of the reforms for model estimation, and the other for model validation which lead to credible policy simulations. In line with the life-cycle hypothesis, we show that older workers who are able to smooth income over partial retirement years are those who can afford partial retirement. High part-time wages, or generous pension provisions or personal savings that supplement part-time wages allow workers to accommodate their preferences to retire gradually. We show that policies that help to smooth consumption during partial retirement make partial retirement attractive.

1 Introduction

The life-cycle hypothesis suggests that individuals make consumption and labor supply decisions to maximize lifetime utility, taking into account anticipated changes in income trajectories, health conditions, and personal preferences. These preferences include an increasing valuation of leisure, reduced tolerance for physical and cognitive strain, and a growing desire for greater control over how and under what conditions they engage in work or daily activities later in life. A key prediction of the life-cycle hypothesis is a gradual withdrawal from the labor market, through reduced working hours or shifts to less demanding roles. This pattern of partial retirement reflects the assumption of the life-cycle hypothesis that individuals seek to smooth

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both consumption and leisure over time, responding progressively to age-related changes while preserving their accustomed standard of living during the transition out of full-time employment. Consistent with this prediction, Kantarcı et al. (2025) find that more than one in three individuals prefer partial retirement over early or late abrupt retirement at any (full) pension eligibility age from 60 to 66 when presented with a stated preference survey that asked them to trade off between leisure and income over the life cycle.

While the life-cycle hypothesis predicts partial retirement, the prevalence of abrupt retirement remains puzzling. Using a stylized life-cycle model of labor supply, Rogerson and Wallenius (2013) show that abrupt retirement can arise as a rational outcome under specific conditions. In particular, if production features nonconvexities – such as fixed costs of working or indivisible labor input – or if individuals exhibit a high intertemporal elasticity of substitution, their model predicts that workers may find it optimal to retire from their full-time job in an abrupt manner. Building on the theoretical insights of Rogerson and Wallenius, Ameriks et al. (2020) provide complementary empirical evidence that emphasizes the role of demand-side constraints in shaping late-in-life labor market behavior. Using stated preference data, they find that many older Americans express a strong willingness to work longer, particularly in jobs with flexible schedule, but perceive a lack of suitable part-time opportunities. This mismatch suggests that nonconvexities in production, such as organizational or technological barriers to part-time hiring, limit partial retirement by restricting the availability of flexible jobs, even for willing workers. Using an employer survey to explore demand-side constraints, Hutchens (2010) find that employers are selective when offering opportunities for phased retirement (i.e., partial retirement while remaining employed with the same employer). Specifically, employers are more likely to permit phased retirement for high-performing employees.

In this paper, we offer an alternative explanation for the limited incidence of partial retirement among most workers. We interpret this as a supply-side phenomenon and argue that only those workers who are able to smooth their consumption during partial retirement are financially positioned to pursue it. In particular, partial retirement entails earning part-time wages that must be supplemented by income from partial pensions or savings in order to sustain full-time earnings levels. Kantarcı et al. (2025) provide supporting evidence that subsidizing hourly wages during partial retirement makes partial retirement substantially more attractive than when the hourly wage remains at the level of the former full-time job.

We derive our evidence from the predictions of a life-cycle model estimated using unique administrative data. Our life-cycle model is dynamic and incorporates novel features to capture the complexity of the decision to retire partially or fully, as faced by forward-looking agents. It allows for savings and pension rights accumulation, continuous consumption and savings choices, a set of four discrete choices over work hours, and a binary pension claiming choice. It accounts for uncertainty in wages, health, and survival. The combination of work-hour and pension claiming choices enables two distinct partial retirement options, each allowing for a different pathway toward a gradual transition into full retirement. Our data includes daily administrative records of wages, hours worked, personal savings, accrued and paid pension rights for all individuals born between 1940 and 1974 and participated in the pension schemes of the largest Dutch pension fund and the state pension fund between 2005 and 2024, allowing for a comprehensive view of individual income and labor activity.

To strengthen our evidence, we exploit two major pension reforms: one validates the model's predictions, while the other enables causal inference. Specifically, individuals in our dataset were subject to two major, cohort-specific changes in pension entitlement rules. The first reform, implemented in January 2006, abolished a widely used early retirement scheme that had allowed participants to retire as early as age 55, receive monthly benefits potentially equivalent to their full salary if retiring close to age 65, and continue accruing pension rights while receiving those benefits. The second reform, implemented in 2013, increased for the first time the entitlement age for state pensions above 65. Both reforms therefore delayed access to pension income, whether through early retirement schemes or the state pension, requiring younger cohorts to remain active in either full-time or part-time work, or to bridge the gap with private savings.

Our findings provide empirical support for the life-cycle hypothesis's prediction of consumption smoothing later in life. We show that individuals who transition into partial retirement by reducing their working hours either increase their labor supply to earn higher wages, draw partial pensions, or rely on personal savings to maintain stable consumption during this period. These behaviors suggest that partial retirement is primarily pursued by those with sufficient financial means to supplement reduced earnings, highlighting the importance of economic resources in enabling a gradual exit from the labor market.

To be completed with other contributions to the labor supply literature.

This paper proceeds as follows. Section 2 describes the Dutch pension policy design and major reforms. Section 3 presents the pension and labor market data and the sample restrictions. Section 4 provides descriptive analyses of employment patterns and partial retirement. Section 5 presents causal evidence on the impact of pension reforms. Section 6 introduces the dynamic model of retirement. Section 7 presents MSM estimates of the dynamic model. Section 8 conducts policy simulations. Section 9 discusses the implications of findings for the economic literature and policy.

2 Pension policy in the Netherlands: Institutional design and major reforms

Retirement income in the Netherlands mainly stands on two pillars: the state and the occupational pension. The General Old-Age Pensions Act (AOW) is the state pension scheme, paying a flat-rate benefit when people reach the state pension age, independent of earnings, income or premiums paid. The benefit level depends on the number of years of residence in the country and on household composition. For those who always resided in the country, it provides households older than the state pension age with a subsistence-level income. The scheme is unfunded and based on the pay-as-you-go principle: current state pensions are financed from the current premiums paid by workers. The premiums are paid through income tax. The statutory retirement age (SRA), the age at which individuals become eligible to claim the state pension, was fixed at 65 for many years, applying to all birth cohorts reaching age 65 up to and including 2013. In 2011, the government announced a gradual increase in the SRA. For example, individuals born between March 1, 1957, and December 31, 1959, became eligible at age 67, while those born in 1962 faced an eligibility age of 67 years and 3 months. Based on current projections, the state pension age will continue to rise in line with life expectancy, reaching 68 by 2040 and 70 by 2070. The scheme does not allow flexible claiming of pension rights.

Participation in the fully funded occupational pension scheme is mandatory for the vast majority of employees. While essentially individual, the scheme includes provisions for surviving spouses and orphans. From the early 1990s until 2005, generous early retirement arrangements (VUT) allowed many workers to retire well before reaching the statutory pension age. Embedded within occupational pension schemes, these arrangements enabled individuals to claim benefits from their 55th birthday onward without reducing lifetime income. Early retirement became widespread, especially among those with stable employment histories and access to collectively negotiated pension pathways. These arrangements were gradually phased out after a 2006 tax reform (RVU) made them financially unattractive.

Today, most occupational pension funds offer flexible retirement options that allow individuals to retire earlier or later than the SRA, as well as to retire partially, before, at, or after reaching that age. Retirement is typically possible from age 60 onward, and can be deferred up to age 70, depending on fund-specific rules and accrued entitlements. These choices are subject to actuarially fair adjustments. As a result, the average retirement age rose from 61 in the early 2000s to nearly 65 by the late 2010s, and continues to rise, reaching around 66.5 by the mid-2020s, in line with the rising state pension age and the decline of early retirement schemes.

The rising state pension age (SRA) and the phasing out of generous early retirement schemes have made early retirement increasingly difficult for older workers, particularly those with health issues or physically demanding jobs. In response, employer and employee organizations introduced subsidized partial retirement schemes ("Generation pact") through collective labor agreements in the late 2010s. Typically starting at age 60 or 62 depending on sector, these allow employees to reduce working hours in the years leading up to their SRA, with a less-than-proportional drop in income and continued pension accrual based on full-time earnings. Sector-specific details vary; a common example is the 80/90/100 variant, where employees work 20% less, earn 90% of their full-time wage, and accumulate pension rights as if working full-time.

To analyze differences in retirement incentives across policy regimes, we analyze six birth cohorts. Table 1 presents these cohorts, detailing their ages at the start and end of the dataset's observation period, the earliest age at which they can claim occupational pensions, and the SRAs at which they can claim state pensions. The first and second cohorts qualify for the state pension at the same age; however, only the first cohort is eligible for generous occupational pensions starting at age 55. In contrast, the second cohort must wait until age 60 to claim occupational pensions. The younger cohorts face progressively higher statutory pension ages, although all retain the option to claim occupational pensions from age 60.

The subsidized partial retirement schemes are unlikely to have affected the observed birth cohorts for two reasons. First, they were introduced only in the late 2010s, near the end of our observation period. Second, by that time, many individuals in these cohorts were already past the typical eligibility ages, often around 60 or 62, for entering such schemes. We therefore do not consider these subsidized schemes as relevant retirement incentives for the cohorts analyzed.

Table 1: Birth cohorts, their ages at the start and end dates of the observation period of the dataset, and their minimum retirement ages for occupational pensions and SRAs for state pensions

Birth cohort	Birth date	Age in years and months on 01.01.2005 (start of observation period)	Age in years and months on 12.31.2019 (end of observation period)	Minimum age of occupational pension eligibility	Sta. ret. age of state pension eligibility in years and months
1	01.11.1949 – 31.12.1949	55+2 – 55+0	70+2 – 70+0	55	65+3
2	01.01.1950 – 30.09.1950	55+0 – 54+3	70+0 – 69+3	60	65+3
3	01.10.1950 – 30.06.1951	54+3 – 53+6	69+3 – 68+6	60	65+6
4	01.07.1951 – 31.03.1952	53+6 – 52+9	68+6 – 67+9	60	65+9
5	01.04.1952 – 31.12.1952	52+9 – 52+0	67+9 – 67+0	60	66+0
6	01.01.1953 – 31.07.1953	52+0 – 51+5	66+11 – 66+5	60	66+4

3 Administrative data and sample restrictions

ABP is the largest pension fund in the Netherlands and ranks among the largest globally, covering approximately 15% of the Dutch population. It serves as the occupational pension fund for employees working in the government and education sectors.[1] Our analysis is based on administrative records from ABP, covering all individuals who participated in a pension scheme between January 2005 and December 2024. Within this time period, we observe individuals born between 1940 and 1974.

From January 2005 to December 2024, we observe the date of birth, gender, marital status, net wages (after taxes and social security contributions), accrued pension rights, and full-time equivalent (FTE). We also observe paid pension rights starting from January 2006. FTE is defined as the ratio of actual hours worked to full-time hours, with the latter set at 38 hours per week in sectors insured by ABP. We observe the precise dates at which changes occur in these variables. Using this information, we construct a panel dataset with monthly observations at the individual level.

Using individuals' unique citizen service numbers (BSN), we link ABP administrative records to those from Statistics Netherlands (CBS), which provide additional information on household assets and disability insurance (DI) benefits. Asset data are available annually from 2006 to 2024 and include financial assets, bank savings, real estate holdings, debts, and mortgages. DI benefits are available monthly from January 1999 to February 2016.

We impose several restrictions on the dataset. First, we restrict our sample to individuals born between November 1949 and July 1953. As Table 1 showed, this range captures career periods during which pension policies changed and individuals were most likely to make retirement decisions. We exclude individuals born before November 1949 because our analysis requires variation across birth cohorts in either the minimum age for occupational pension eligibility or the SRA for state pension eligibility, but not in both simultaneously. For cohorts born before November 1949, both eligibility ages (55 and 65, respectively) differ from those of all cohorts included in Table 1. Individuals born after July 1953 are excluded, as they reach their SRA only after the end of our observation period in December 2019. Consequently, we cannot observe retirement decisions triggered by reaching the statutory pension age for this group.

Second, we focus on individuals who are employed at the age of 55 years and 2 months, the youngest age the oldest birth cohort is observed at the start of the observation period as Table 1 showed. This selection is not restrictive since approximately 85% of the individuals in the original dataset are working at this age.

Third, we limit our analysis to men. Among employed women in the dataset, 60% work part-time and this proportion remains stable between ages 55 and 65. This suggests that women rarely transition gradually from full-time employment into retirement. Since our objective is to examine patterns of gradual retirement from full-time positions, we exclude woman from our analysis.

Finally, we exclude individuals who, during the observation period, transitioned from a sector insured by ABP to one not insured by ABP, thereby accruing pension rights in a different fund. This restriction affects only a small subset of the sample and does not influence our qualitative conclusions.

These sample restrictions yield a final analytical sample comprising 8,519,210 observations for 62,402 individuals. These individuals fall into the six birth cohorts detailed in Table 1 as follows: 2,456 in the first cohort, 11,554 in the second, 12,358 in the third, 12,562 in the fourth,

[1] The government sector includes the central government, provinces, municipalities, water boards, the military, police, judiciary, and all civil servants. The education sector encompasses all levels of schooling, universities, public research institutes, and university medical centres.

13,566 in the fifth, and 9,906 in the sixth cohort.

4 Employment patterns in late career and partial retirement

Figure 1 presents full- and part-time employment rates over time for individuals aged 55 and 2 months to 66 years and 11 months, the earliest and latest ages at which all birth cohorts are observed throughout the available data period. We define full-time work as working at least 0.875 FTE. As explained in Section 3, the sample is restricted to individuals employed at age 55 years and 2 months. The figure shows that approximately 90% of the sample is engaged in full-time work at this age. This high rate of full-time employment is desirable for our analyses, as it provides a large baseline population from which transitions into abrupt or partial retirement can be observed and compared across cohorts.

The proportion of individuals engaged in full-time employment declines progressively with age, with pronounced drops at age 62 for birth cohort 1, and a sharp decline near SRAs for all cohorts. These patterns are consistent with institutional eligibility thresholds and actuarial rules: individuals in cohort 1 (Table 1) become eligible for generous occupational pensions with no actuarial penalty at age 62, and all cohorts become eligible for state pensions at the SRA.

Cohort 1 consistently shows lower rates of full-time labor market participation across all ages due to higher rates of retirement or part-time work facilitated by the more generous occupational pension provisions available to this group. The bottom panel of Figure 1 provides evidence of increased part-time work among this group.

Cohorts 2-6 retire later, reflecting increases in the SRA. Compared to cohort 2, full-time employment is already more prevalent in cohort 6 beginning at age 60. This pattern is consistent with forward-looking labor-supply behavior. When the SRA increases, individuals reassess their entire late-career trajectory: they anticipate a longer period until public pension eligibility and recognize that exiting the labor force early would leave them without pension income for a longer time. In response, they adjust their labor supply well before reaching the SRA. Higher full-time participation around age 60 therefore reflects precautionary behavior: workers increase earnings and pension accrual earlier in order to maintain financial security over a longer pre-pension horizon.

Relative to cohort 2, cohort 6 is also more likely to work part-time from age 60 onward. Again, this pattern suggests an anticipatory adjustment in labor supply. Facing a higher SRA, individuals expect a longer working life and reduce hours earlier to sustain employment over this extended horizon. Due to the SRA reform, part-time employment becomes a more feasible option than full-time work, allowing individuals to preserve some earnings and pension accrual in some form of phased retirement.

Overall, the patterns in Figure 1 suggest that cohorts adjust their late-career labor supply in different ways, reflecting variation in pension generosity and rising retirement ages. For cohort 1, the adjustment runs from working full-time to part-time work: generous occupational pensions make reduced hours financially viable and smooth consumption when hours fall. For cohort 6, the adjustment instead runs from non-employment to part-time: when full-time work is not feasible, part-time hours help maintain labor-market attachment and smooth consumption through continued earnings and pension accrual until the higher SRA.

Figure 2 distinguishes between individuals who claim and those who do not claim partial pensions while working part-time. Under pension regulations, once an individual reduces their work hours and claims a partial pension, this decision is irrevocable at subsequent ages. Accordingly, individuals shown in the upper panel, those who have claimed a partial pension, cannot reappear in the lower panel. In contrast, individuals who reduce their work hours without claiming a partial pension retain the option to do so later. Therefore, individuals in the lower panel may subsequently transition to the upper panel. Among those who initially forgo claiming (lower panel), only 18% eventually claim a partial pension at a later age (upper panel).

In the upper panel of Figure 2, part-time employment with pension claiming rises steadily from age 60 among cohorts 2-6, peaking between ages 63 and 65. This pattern suggests that partial pensions help finance partial retirement at ages when the disutility of work becomes increasingly important. Cohort 1 engages in partial retirement with pension claiming significantly more often, most likely due to the attractiveness of this option afforded by more generous occupational pension provisions.

At all ages, part-time employment without pension claiming is more prevalent than part-time employment combined with pension claiming, as shown by comparing the lower and upper panels of Figure 2. For cohorts 2-6, this is not surprising before age 60, as these cohorts are not yet eligible to claim partial pension benefits to supplement part-time earnings. From age 61 onward, however, they can draw partial pensions, and, as the upper panel shows, they increasingly make use of this option. Cohort 1 engages in this form of part-time employment less frequently, reinforcing our premise that generous occupational pension provisions increase the appeal of partial retirement. A key implication of these findings is that access to partial pensions or pension subsidies allow individuals to supplement part-time earnings with partial pensions, enabling consumption smoothing and making partial retirement more affordable. By contrast, younger cohorts may need to rely more heavily on personal savings or increase their working hours to achieve similar consumption smoothing. To explore this further, we examine additional descriptive statistics.

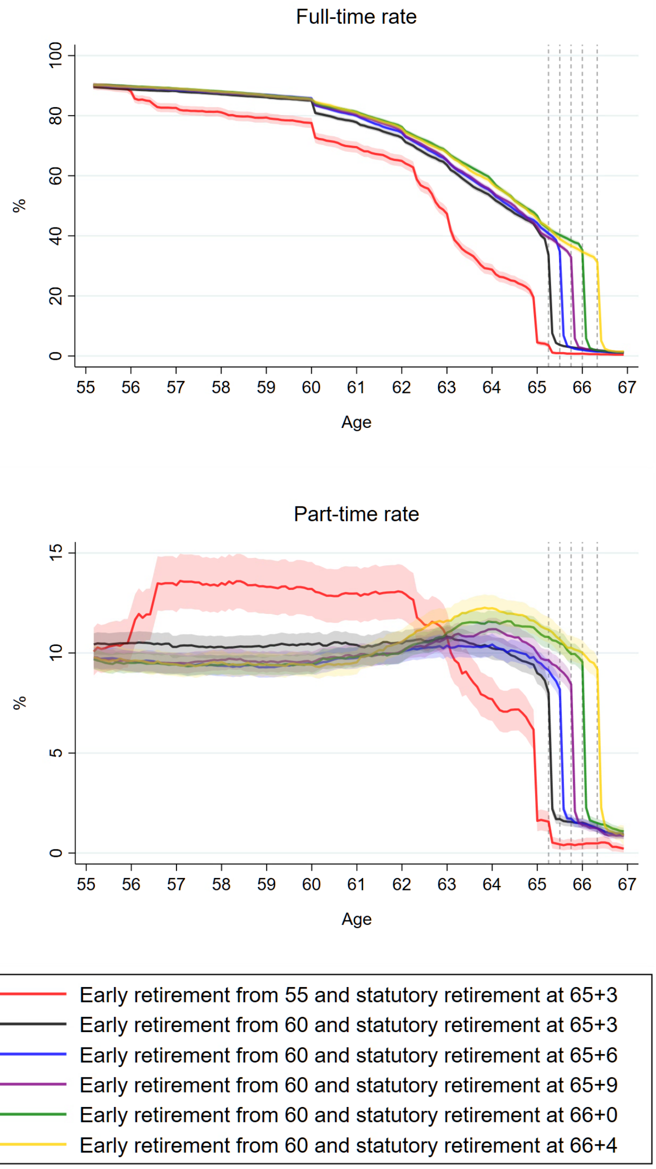

Figure 1: Fractions of individuals working full-time and part-time from age 55 to 68.

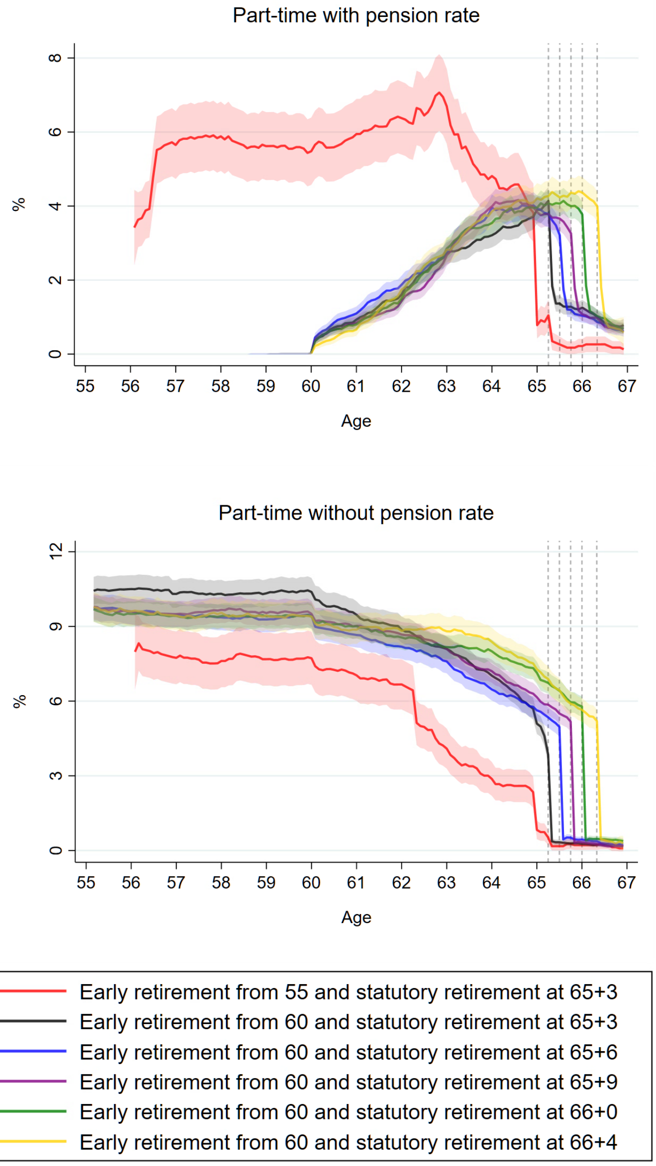

Figure 2: Fractions of individuals working part-time and claiming partial pensions (upper panel), and individuals working part-time without any claim of partial pensions (lower panel) from age 55 to 68.

We define partial retirement as the transition from full-time employment at age 55 years and 2 months to uninterrupted part-time work of any duration prior to full retirement. By only studying the part-time employment rates in Figure 1, we cannot distinguish between deliberate transitions into partial retirement and stable patterns of part-time work or temporary reductions in hours. In our sample, between age 55 years and 2 months and age 67, 23% of individuals work part-time at some point, 12% meet the criteria for partial retirement, 8% are observed to be always working part-time, and 3% alternate between part-time and full-time employment.

Table 2 provides descriptive statistics on partial retirement across birth cohorts. Approximately 12% of individuals partially retire from their full-time position at some point between age 55 years and 2 months and age 67, with no notable variation across birth cohorts. This indicates that much of the part-time employment observed in Figure 1 reflects participation in a partial retirement trajectory. The oldest cohort begins partial retirement earlier and spends more years in this state, likely reflecting their ability to afford it due to generous occupational pension provisions available to them. Their notably higher pension claiming rate supports this interpretation. Their lower rate of DI claiming may indicate that pension benefits substitute for DI.

Table 2: Partial retirement statistics by birth cohort

	Birth cohort					
	1	2	3	4	5	6
In partial retirement (%)	0.13	0.11	0.11	0.12	0.12	0.12
	(0.34)	(0.31)	(0.32)	(0.32)	(0.33)	(0.32)
Age at onset of partial retirement	59.93	62.15	62.34	62.55	62.62	62.60
	(3.38)	(2.76)	(2.67)	(2.58)	(2.66)	(2.66)
Age at end of partial retirement	63.45	64.55	64.68	64.87	65.04	65.18
	(1.93)	(1.80)	(1.79)	(1.72)	(1.83)	(1.85)
Duration of partial retirement (Yrs)	3.52	2.40	2.35	2.32	2.42	2.59
	(2.81)	(2.08)	(1.95)	(1.99)	(2.01)	(2.10)
Claiming pension during partial retirement (%)	0.82	0.64	0.62	0.60	0.55	0.50
	(0.38)	(0.48)	(0.48)	(0.49)	(0.50)	(0.50)
Claiming DI during partial retirement (%)	0.07	0.12	0.09	0.09	0.09	0.09
	(0.25)	(0.33)	(0.29)	(0.28)	(0.29)	(0.29)

Note: Standard deviation in parentheses.

In Figure 3, we analyse how individuals navigate the financial transition into partial retirement. We draw on differences in whether individuals claim pension benefits, DI, or neither to understand the mechanisms that make partial retirement financially feasible.

The top panel shows an obvious reduction in working hours, transitioning from full-time or near full-time employment at the onset of partial retirement. Notably, however, the largest decline is observed among pension and DI recipients, suggesting that access to these benefits plays an important role in determining labor supply decisions. These groups reduce their hours more dramatically, as the supplementary income from benefits helps offset the loss of earnings. In contrast, those without benefit claims maintain higher number of work hours, relying more on labor income to smooth consumption.

The middle panel confirms the pattern observed in the top panel: while gross income declines across all groups, the reduction is less pronounced for pension and DI recipients. This suggests that benefit income helps offset the loss of labor earnings. These groups can therefore afford to work fewer hours during partial retirement, as their benefit income supplements part-time wages and supports continued consumption smoothing.

The bottom panel shows personal assets across the three groups. Individuals who do not claim benefits possess significantly more assets than those who do. This disparity may help explain their lower reliance on benefits: people with substantial savings or assets are less likely to seek income from benefits. Beyond these group-level differences, none of the three groups appear to decumulate assets during partial retirement to smooth consumption. This aligns with evidence from the Netherlands, where retirees often treat accumulated assets as a long-term reserve rather than a source of regular spending (Van Ooijen et al., 2015). This may help explain why wealthier individuals work more during partial retirement: since they neither rely on benefits nor draw down savings, they depend more heavily on labor income to finance consumption.

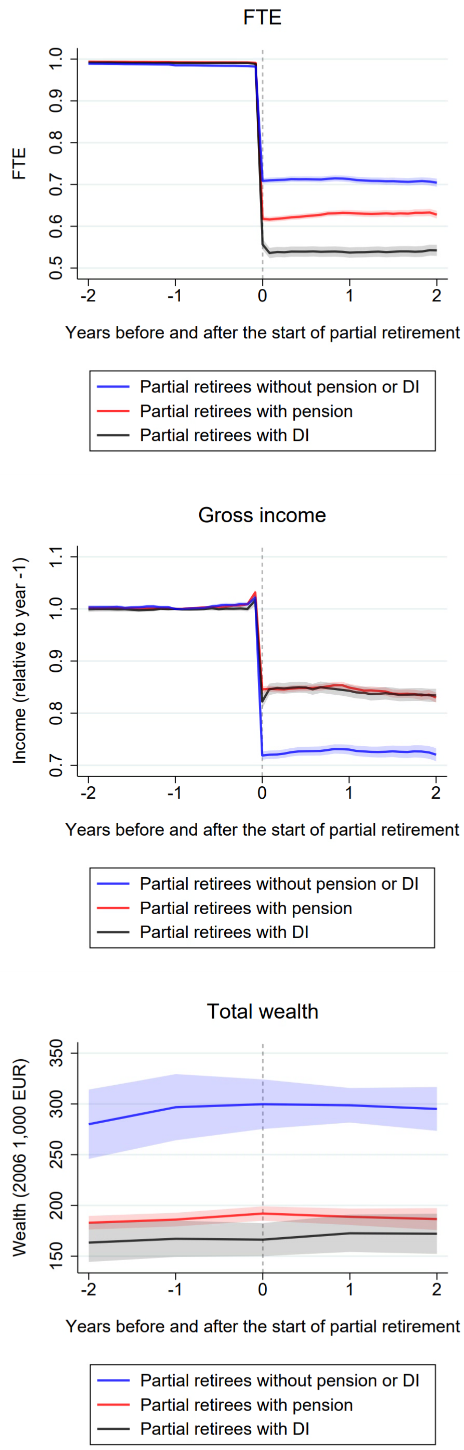

Figure 3: Labor Supply, earnings, and assets in the years before and after the start of partial retirement, by pension and DI claiming status.

5 Reduced-form analysis and results

This section documents the reduced-form effects of the two major pension reforms on labor supply. The aim is twofold. First, the DiD estimates provide transparent, model-free evidence on how individuals adjusted their employment behavior when early retirement provisions were abolished and when the SRA was increased. Second, these reduced-form patterns serve as an empirical benchmark for the structural analysis that follows. In particular, the behavioral responses uncovered here motivate the key mechanisms embedded in the dynamic life-cycle model and inform the choice of moments used in the Method of Simulated Moments (MSM) estimation.

5.1 DiD model

Building on the descriptive patterns illustrated in Figure 1, we formalize labor supply responses to the two major pension reforms taking a DiD approach.[2] Specifically, we estimate the following linear probability model:

$$y_{it} = \alpha_i + \sum_{k=1}^{24} \beta_{k(t)} \left(Treated_i \times d_{k(t)} \right) + \sum_{k=1}^{24} \gamma_{k(t)} d_{k(t)} + \varepsilon_{it}. \tag{1}$$

i indexes individuals. t indexes age in months, beginning at 55 years and 2 months and extending to 66 years and 11 months. k denotes age categories defined in six-month intervals, the first category covering ages from 55 years and 2 months to 55 years and 5 months, and the final category covering ages from 66 years and 6 months to 66 years and 11 months. We conduct the analysis by age in six-month intervals as finer distinctions are not meaningful for our purposes.

α_i captures individual fixed effects. $Treated_i$ is a binary indicator equal to one for individuals in the treatment group. The dummy $d_{k(t)}$ identifies age category k. The coefficients $\beta_{k(t)}$ measure the treatment effect at each age category relative to the baseline category, defined as the age group immediately preceding the reform announcements. The outcome variable y_{it} is a binary indicator for either full-time or part-time employment. Standard errors are clustered at the individual level.

5.2 Reduced-form estimates

In the left panel of Figure 4, we examine the impact of abolishing the early retirement scheme. We consider two adjacent birth cohorts: individuals born between November 1 and December 31, 1949, and those born between January 1 and September 30, 1950 (birth cohorts 1 and 2 in Table 1). While both cohorts face the same SRA, they differ in their access to generous early retirement pensions, allowing us to estimate the effect of changing early retirement incentives on labor market participation. To isolate the causal effect of the reform, we restrict the control group to individuals born in December 1949, the final month of the earlier cohort, and define the treatment group as those born in January 1950, the first month of the later cohort. This narrow comparison minimizes age-related confounding and ensures that both groups are similar in observable characteristics except for their exposure to the reform.

We define the treatment threshold using the reform announcement date: July 7, 2005. On this date, the control group was 55 years and 7 months old, while the treatment group was 55 years and 6 months old. Accordingly, we define the pre-treatment period as being younger than

[2] In Appendix B, we present results from a regression discontinuity (RD) approach and show that both identification strategies yield the same qualitative conclusions for all outcomes, as well as similar magnitudes of the reform effects.

55 years and 6 months, and the post-treatment period as being at this age or older. Prior to completing age 55, neither group is eligible to claim occupational pension rights (Section 2); after this age, only the control group is eligible for generous early retirement provisions from their occupational pension fund.

As already shown in Figure 1, the two groups exhibit nearly identical full- and part-time employment rates during age 55, a period during which neither cohort is eligible for generous occupational pensions. This results in a zero treatment effect prior to eligibility and lends support to the common trends assumption. Beginning at age 56, when the control group becomes eligible for generous occupational pensions, the full-time employment rate starts to diverge. This divergence becomes especially pronounced from age 62 onward. When both groups reach the SRA, their full-time employment rates converge leading to no treatment effect. As discussed in relation to Figure 1, these patterns are consistent with institutional pension eligibility thresholds and actuarial rules, and highlight the strong influence of financial incentives on continued labor market engagement.

The estimates for part-time employment also mirror the patterns shown in Figure 1. Before age 62, the treatment effects are negative, indicating that generous pension provisions allow individuals in the control group to afford partial retirement. After age 62, when claiming pensions no longer triggers actuarial penalties, full retirement becomes financially attractive, leading to a shift away from part-time work. The wide confidence intervals reflect the small sample size, as the analysis compares cohorts born within a month across control and treatment groups.

In the right panel of Figure 4, we examine the impact of increasing the SRA. We consider two birth cohorts: individuals born between January 1 and September 30, 1950, and those born between January 1 and July 31, 1953 (birth cohorts 2 and 6 in Table 1). Early retirement provisions are not available to these cohorts, while cohort 6 becomes eligible for the state pension and actuarially neutral occupational pensions at a higher age. To isolate the causal effect of the reform, we restrict the control group to individuals born in January 1950, the first month of the earlier cohort, and define the treatment group as those born in January 1953, the first month of the later cohort. We define the treatment group as individuals born in January 1953, rather than July 1953, to increase the number of observations in the treatment group. By selecting cohorts furthest apart, we maximize the age contrast at pension eligibility thresholds.

We define the treatment threshold using the reform announcement date: June 10, 2011. On this date, the control group was 61 years and 5 months old, while the treatment group was 58 years and 5 months old. Accordingly, we define the pre-treatment period as being younger than 58 years, and the post-treatment period as being at this age or older. Prior to reaching age 58, neither group is officially aware that their SRA will be increased; after this point, anticipatory responses become more likely for the treatment group, whose SRA is higher.

The estimates align with the patterns shown in Figure 1. The treatment effect is statistically indistinguishable from zero prior to the treatment cut-off, supporting the common trends assumption. By age 60, treatment group already exhibits higher rates of full-time employment than the control group. The rise in full-time work likely reflects precautionary behavior, with individuals working more to build financial security in anticipation of early exit before reaching their higher SRA. In contrast, the increase in part-time work at later ages can indicate gradual adjustment in hours to accommodate a longer expected working life.

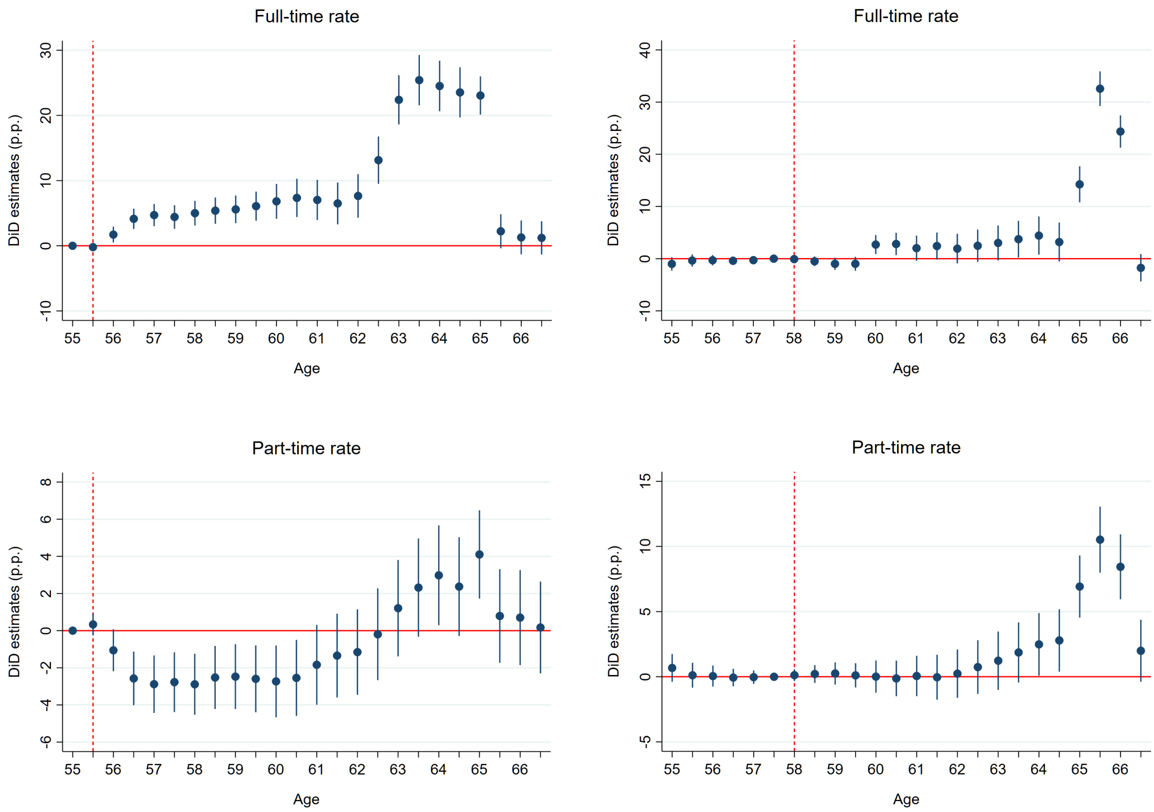

Figure 4: Impact of the early retirement (left panel) and SRA (right panel) reforms.

6 Dynamic model of labor supply, pension claiming, and consumption

In our exploratory and reduced-form analyses in Sections 4 and 5, we relied on both exogenous changes in pension incentives and individuals' endogenous choices regarding the claiming of partial pension rights. These analyses helped clarify why, for some individuals, partial retirement emerges as financially more feasible than either continued full-time work or complete retirement. Here, we develop and estimate a dynamic programming model to explain this behavior rigorously and use it for policy simulations. The model captures how forward-looking individuals weigh labor income against pension entitlements over time, allocating resources between consumption and savings. To characterize preferences, we specify how individuals trade off consumption and leisure across periods, and how they discount future utility relative to present utility. We begin by describing the agent's decision problem, in which individuals maximize expected discounted lifetime utility by choosing labor supply, pension claiming, and savings, subject to both endogenous and exogenous state variables. We then present our estimation strategy and explain how the structural preference parameters are recovered from the data. Our model specification and estimation approach build on leading contributions in the literature, including De Bresser (2024), De Nardi et al. (2025), and French et al. (2022). For ease of reference, Tables 5 and 6 in Appendix C.1 provides a complete summary of the model's notation, including decision variables, state variables, and parameters.

6.1 Agent's optimization problem

In this section, we first define the agent's decision and state variables, and then specify the functional forms for preferences, budget constraints, and the stochastic processes that govern the environment.

6.1.1 Decision and state variables

We begin by defining the agent's decision variables, state variables, and payoff variable, which together determine the feasible choices, the evolution of the state, and the flow return in each period.

Decision variables

Agents are indexed by i. Time is indexed by t, which is discrete and represents age in years. The description of the environment in period t for agent i consists of two components. The first component is a vector of decision variables, $d_{it} = \{h_{it}, o_{it}, c_{it}\}$. The earliest age at which an agent makes decisions is $t = t_0$, and the maximum possible age is $t = 100$. We set $t_0 = 56$, since this is the first period in which asset data are available for birth cohorts 1 and 2 (Table 2). Each agent faces an exogenous probability of death that increases with age and reaches one at $t = 100$. Hence, the decision horizon is finite, agent-specific, and bounded above by 100.

The variable h_{it} represents annual hours of work and takes values from the baseline choice set $\mathcal{H} = \{0, 1000, 1600, 2000\}$. 0 represents non-employment. Non-employment is treated as a voluntary choice, which implies that involuntary job separation is not allowed in the model. Accordingly, we exclude unemployment, which is assumed to be involuntary. This assumption is not restrictive, as at most 1% of individuals in our sample receive unemployment insurance at any age. 2000 represents full-time work, following the subject literature (French, 2005; French and Jones, 2011). Intermediate values represent part-time work and correspond to 0.5

and 0.8 FTE, respectively, the two most common full-time equivalencies observed in the data (Figure 13).

We assume that agents can freely reduce their number of work hours, which implies that demand-side constraints do not bind. This assumption is consistent with the Dutch Flexible Working Act, which grants employees the right to request a reduction in working hours. Employers must respond to such requests in writing and may only refuse them if there are compelling business interests that justify doing so.

On the other hand, the baseline choice set $\mathcal{H}$ is restricted in two respects and implies that the feasible choices at a given age constrain future choices. First, individuals cannot work after reaching the age of state pension eligibility, as employment contracts are terminated at that point in the Netherlands. Second, hours of work cannot increase with age, which means that the choice set is restricted by past decisions. These assumptions imply that retirement is an absorbing state: once retired, individuals cannot transition back into employment. Since upward shifts in hours are rare in the data, we impose this monotonicity restriction to reduce the computational burden.

The variable $o_{it} \in \mathcal{O} = \{0, 1\}$ denotes the binary decision to claim occupational pension rights. The minimum claiming age for these rights is cohort-specific (Table 1). We assume that all individuals claim their accrued occupational pension rights no later than the state pension age. This assumption is supported by our observation that in the data nearly all individuals claim occupational pension rights once they become eligible to claim accrued state pension rights (Figure 15).

The claiming decision for occupational pension rights is independent of that for state pension rights, which are automatically paid at the SRA. Under ABP regulations, the claiming decision is irreversible. Therefore, as with the choice set $\mathcal{H}$, feasible choices from the set $\mathcal{O}$ at a given age constrain future choices.

Under ABP regulations, individuals may claim a fraction of accrued occupational pension rights while working, up to a maximum of $(1 - \text{FTE})$. We do not model a decision of claiming a fraction of accrued rights. Instead, we assume that, conditional on the pension claiming decision and a given labour supply choice, individuals claim the maximum rate permitted by regulation. This assumption is strongly supported by observed behavior in the data (Figure 14). Accordingly, we allow agents to participate in two partial retirement schemes: working 0.5 FTE while claiming 50% of pension rights, or working 0.8 FTE while claiming 20%.

Agents weigh labor income against pension entitlements across time and allocate resources between consumption and savings. The last decision variable, consumption, is denoted by $c_{it} \in \mathcal{C}(h_{it}, o_{it}, x_{it})$. We assume a continuous consumption choice set, which allows any positive level of consumption but is constrained by available resources. In particular, the maximum feasible level of consumption depends on income and savings, as determined by current choices h_{it} and o_{it} together with the state variables introduced below. Borrowing is not permitted.

State variables

The second component of the description of the environment in period t for agent i is the vector of state variables, $x_{it} = \{t, w_{it}, p_{it}, s_{it}, k_i, a_{it}, m_{it}\}$. The variable w_{it} is continuous and represents the annual full-time wage available to the agent in period t if the agent chooses to work. It is treated as an exogenous variable, since wages are determined outside the agent's decision process.

p_{it} is continuous and represents accrued pension rights at the start of period t. It is an endogenous variable since it depends on the agent's labour supply decisions and the pension premiums paid over the full-time wage.

s_{it} represents retirement status. It is an endogenous state variable, determined by the agent's labour supply and pension claiming decisions, h_{it} and o_{it}. Since both decisions are discrete, s_{it} is discrete as well.

k_i indicates the agent's birth cohort, determined by date of birth. Since pension rules vary across cohorts, k_i serves as the exogenous variable that governs which pension regime applies to the agent.

a_{it} is continuous and represents the assets available at the start of period t. It accumulates endogenously, as it depends on, among others, past savings and consumption decisions.

m_{it} is a binary indicator of health status, distinguishing between good and bad health. It is treated as an exogenous variable, since health is taken as given by the agent.

t, s_{it} and k_i together constrain the baseline choice sets $\mathcal{H}$ and $\mathcal{O}$ so that $h_{it} \in \mathcal{H}(x_{it})$ with $\mathcal{H}(x_{it}) \subseteq \mathcal{H}$ and $o_{it} \in \mathcal{O}(x_{it})$ with $\mathcal{O}(x_{it}) \subseteq \mathcal{O}$. The entire vector of state variables x_{it} determines the upper bound of the consumption choice set $\mathcal{C}$, such that the agent's consumption decision satisfies $c_{it} \in \mathcal{C}(h_{it}, o_{it}, x_{it})$.

Payoff variable

The third component, $\tau(d_{it}, x_{it})$, is the payoff variable. It maps the decision and state variables into current-period net income by aggregating earnings, disability benefits, and pension benefits, and subtracting income taxes, asset taxes, and social security contributions. This net-income payoff constitutes the flow return in period t, determining both the current-period reward that enters the Bellman equation and the immediate consumption-leisure trade-off faced by the individual.

6.1.2 Preferences and functional forms

Having introduced the agent's decision and state variables, we now specify the preferences and functional forms that govern utility, income processes, and constraints.

Preferences

Agents derive utility from consumption and leisure according to

$$u(c_{it}, l_{it}) = \frac{1}{\lambda} c_{it}^{\lambda} + \psi \frac{1}{\gamma} l_{it}^{\gamma}, \tag{2}$$

where c_{it} denotes annual consumption and l_{it} denotes leisure. The parameters λ and γ govern the curvature of utility with respect to consumption and leisure, respectively. ψ scales the weight of leisure in utility relative to consumption and therefore shifts the marginal rate of substitution between leisure and consumption.[3]

Following French (2005) and French and Jones (2011), leisure is defined by the time-budget constraint, which states that individuals have a fixed yearly endowment of 4,000 hours that must be allocated between work, leisure, and health-related time, according to

$$l_{it} = \frac{4,000 - h_{it} - \delta\, m_{it}}{4,000}. \tag{3}$$

h_{it} is annual hours worked. m_{it} is a binary indicator of bad health as defined in the preceding section. δ is the health time penalty parameter, representing the reduction in the yearly time

[3] This functional form of utility is similar to Gustman and Steinmeier (2005) and Keane and Wasi (2016). Assuming non-separable utility in consumption and leisure results in a worse model fit to the data, especially with respect to assets accumulation over time.

endowment available for leisure when an individual is in bad health. We expect the estimate of parameter δ to be positive, indicating that bad health reduces the effective time endowment available for leisure and thereby increases the marginal utility of leisure relative to healthy individuals. This formulation implies that leisure l_{it} is a continuous variable bounded between 0 and 1, representing the share of the yearly time endowment allocated to leisure.

Following De Nardi (2004), agents also derive utility from leaving a bequest, modeled as

$$q(a_{i,t+1}) = \frac{\rho_1}{\lambda} \left(\rho_2 + a_{i,t+1}\right)^{\lambda}, \tag{4}$$

where $a_{i,t+1}$ denotes the assets passed on if death occurs at the end of period t. The parameter ρ_1 governs the overall strength of the bequest motive relative to utility from consumption and leisure, while ρ_2 shifts the function and influences its curvature. The bequest function uses the same curvature parameter λ as the utility from consumption. Using the same λ means the model imposes a common degree of curvature and risk aversion for both consumption and bequests.

Wages

Among the state variables in the vector x_{it}, wage w_{it} and health status m_{it} are the only two that evolve stochastically. We assume that the logarithm of gross full-time wage, $\ln(w_{it})$, follows an autoregressive process:

$$\ln(w_{it}) = \alpha + \phi \ln(w_{i,t-1}) + \epsilon_{it}, \tag{5}$$

where current wage depends on last period's wage and an idiosyncratic shock. The error term is assumed to be normally distributed, $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$, and independently and identically distributed across individuals and time.

These modeling assumptions are consistent with the institutional context faced by Dutch public sector employees. Wages are determined by collective labour agreements, which establish salary scales prescribing increases with years of tenure and leaving little scope for individual bargaining. In practice, most individuals in our sample have likely reached the top of their wage scale by the age of 56, when they enter the model. Initial wages $w_{i,56}$ can therefore capture heterogeneity across dimensions such as education or occupation, but their subsequent law of motion is assumed to depend only on last-period wage and not on other state variables.

Full-time wages w_{it} enter the agents' maximization problem through earnings y_{it}, which are proportional to hours worked:

$$y_{it} = f_{it} \cdot w_{it} \cdot \exp[\log(\eta)\, I\{f_{it} < 1\}], \tag{6}$$

where f_{it} denotes FTE, defined as $f_{it} = \frac{h_{it}}{2{,}000}$. Earnings incorporate a penalty for part-time work, consistent with evidence from the literature (see, e.g., Russo and Hassink, 2008 for the Netherlands). In this formulation, the parameter $\eta \in (0, 1)$ determines the magnitude of the penalty, with $1 - \eta$ representing the proportional earnings loss associated with part-time employment.

Health

The second stochastic state variable, m_{it}, is a binary indicator of bad health. Its dynamics are modeled as a logistic probability that depends on age and last period's health status:

$$\Pr(m_{it} = 1 \mid m_{i,t-1}, t) = \frac{\exp(\mu_0 + \mu_1 t + \mu_2 m_{i,t-1})}{1 + \exp(\mu_0 + \mu_1 t + \mu_2 m_{i,t-1})}. \tag{7}$$

The parameters μ_0, μ_1, and μ_2 govern the baseline probability, the effect of age, and the persistence of health status, respectively. This specification implies that the likelihood of poor health increases with age and depends on whether the individual was already unhealthy in the previous period.

The health status affects agents' choices in three ways. First, health directly influences the utility derived from leisure, as specified in equation(3).

Second, individuals in bad health receive disability insurance (DI) benefits, so health status affects income directly. In the Netherlands, DI pays 70% of pre-sickness wages multiplied by a disability grade, where the disability grade equals one minus the remaining work capacity expressed in FTE. Eligibility requires a disability grade of at least 35%. In the sample data, 75% of DI recipients have a disability grade below 80%, meaning they are partially disabled, and 50% of recipients fall between 35% and 65%. For tractability, we assume that all individuals in bad health ($m_{it} = 1$) have a disability grade of 50%. DI benefits b_{it} are therefore modeled as

$$b_{it} = m_{it} \cdot 0.7 \cdot w_{it} \cdot 0.5. \tag{8}$$

Third, health restricts the feasible choice set for hours worked. Specifically, $\mathcal{H}(X_{it}) = \{0, 1000\}$ if $m_{it} = 1$, meaning that sick individuals can supply at most 1,000 hours per year (FTE = 0.5). This assumption is consistent with assigning all individuals in bad health a disability grade of 50%.

Retirement status

Retirement status s_{it} is a discrete endogenous state variable that evolves deterministically based on the individual's labour supply and pension-claiming decisions in the previous period, $h_{i,t-1}$ and $o_{i,t-1}$. Table 3 illustrates how each combination of hours worked and pension claiming decision translates into one of eight possible retirement states in the following period. Note that state $s_{it} = 2$ cannot occur, since individuals are not permitted to work full-time while simultaneously claiming pension.

Table 3: Mapping of labour supply and pension claiming at t to retirement status in $t + 1$

h_{it}	o_{it}	$s_{i,t+1}$
2,000	0	1
2,000	1	2
1,600	0	3
1,600	1	4
1,000	0	5
1,000	1	6
0	0	7
0	1	8

This implies that h_{it} and o_{it} jointly determine $s_{i,t+1}$, which in turn defines the feasible choice sets of hours of work and pension claiming in the next period, $\mathcal{H}(x_{i,t+1})$ and $\mathcal{O}(x_{i,t+1})$. As described in the preceding section, we assume that hours worked cannot increase with age.

Consequently, the feasible choice set $\mathcal{H}(x_{it})$ depends on s_{it} as follows:

$$\mathcal{H}(x_{it}) = \begin{cases} \{0, 1000, 1600, 2000\} & s_{it} = 1 \\ \{0, 1000, 1600\} & 3 \leq s_{it} \leq 4 \\ \{0, 1000\} & 5 \leq s_{it} \leq 6 \\ \{0\} & 7 \leq s_{it} \leq 8 \end{cases}$$

Similarly, pension claiming is an absorbing decision: once agents begin claiming, they must continue to do so. This implies the following feasible claiming sets:

$$\mathcal{O}(x_{it}) = \begin{cases} \{0, 1\} & s_{it} \text{ is odd} \\ \{1\} & s_{it} \text{ is even} \end{cases}$$

Occupational pension rights

Occupational pension rights p_{it} are modeled as an endogenous state variable that evolves according to the accrual rules of the ABP scheme as described in Kantarcı et al. (2013):

$$p_{i,t+1} = p_{it} + f_{it} \cdot z(k_i) \cdot \big(w_{it} - g(k_i)\big). \tag{9}$$

Pension rights accrue over pensionable income, defined as the full-time wage w_{it} net of the state pension offset $g(k_i)$. This offset reflects that participants simultaneously build entitlements under the public old-age pension (AOW). Because contributions to the occupational plan are proportional to full-time equivalence, pension rights accumulate in proportion to f_{it}. Accrual occurs at rate $z(k_i)$, which is calibrated by the pension fund to deliver a targeted replacement rate at retirement. Both $g(k_i)$ and $z(k_i)$ vary across birth cohorts due to the early retirement reform implemented in 2006:

$$g(k_i) = \begin{cases} 15,500 & k_i \leq 1949, \\ 9,600 & k_i \geq 1950, \end{cases}$$

and

$$z(k_i) = \begin{cases} 1.75\% & k_i \leq 1949, \\ 2.05\% & k_i \geq 1950. \end{cases}$$

Before retirement, p_{it} represents only accumulated rights, a proposal of how much could eventually be received. It is only at the point of claiming that these rights are transformed into the actual annuity entitlement e_{it}, which determines the income stream in retirement:

$$e_{it} = o_{it} \cdot (1 - f_{it}) \cdot p_{it} \cdot g(d_{it}, x_{it}). \tag{10}$$

This entitlement reflects the individual's claiming choice, captured by the binary indicator o_{it}, and is adjusted for partial pension claiming through the full-time equivalent factor $(1 - f_{it})$. The actuarial adjustment function $g(d_{it}, x_{it})$ adjusts the payout to account for the age at claiming. By contrast, state pension benefits g_{it} are automatically paid at the cohort-specific SRA.

Budget constraint

Next-period assets are determined by the budget constraint

$$a_{i,t+1} = \big(a_{it} + N(d_{it}, x_{it}) - c_{it}\big)(1 + r), \tag{11}$$

where $N(d_{it}, x_{it})$ denotes net income. Net income incorporates earnings, disability benefits, occupational and state pension entitlements, social security and national insurance contributions, pension contributions, income and asset taxes, and applicable tax credits. The inner term $a_{it} + N(d_{it}, x_{it}) - c_{it}$ represents end-of-period assets before returns, and multiplying by $(1 + r)$ yields next-period assets under a constant net return r on the asset stock.

In contrast to most dynamic programming models of retirement, our framework embeds the full set of institutional rules governing social security and national insurance contributions, taxation, and pension accrual. This allows the model to capture the precise incentives individuals face in the Dutch system. All institutional details are documented in Appendix C.2.

Assets and borrowing condition

Assets a_{it} are an endogenous state variable evolving deterministically according to (11). We impose a no-borrowing condition,

$$a_{i,t+1} \geq 0, \tag{12}$$

for all t, so that assets cannot fall below zero. The budget constraint together with the no-borrowing condition (12) determines the feasible consumption set $\mathcal{C}(x_{it})$. The feasible asset set is $\mathcal{A} = \mathbb{R}_+$, so that $a_{it} \in \mathcal{A}$ for all t.

Feasible decision set

Given the state vector x_{it} and the restrictions on labour supply, pension claiming, consumption, and borrowing, the feasible decision set in period t is

$$\mathcal{D}(x_{it}) = \{d_{it} \mid h_{it} \in \mathcal{H}(x_{it}),\ o_{it} \in \mathcal{O}(x_{it}),\ c_{it} \in \mathcal{C}(h_{it}, o_{it}, x_{it}),\ a_{i,t+1}(d_{it}, x_{it}) \in \mathcal{A}\}\,.$$

6.1.3 Dynamic optimization problem

The agent's dynamic optimization problem can be expressed in recursive form as:

$$V_{it}(x_{it}) = \max_{d_{it} \in \mathcal{D}(x_{it})} \left\{u(c_{it}, l_{it}) + \pi_t \beta\, \mathbb{E}\left[V_{i,t+1}(x_{i,t+1}) \,\middle|\, x_{it}, d_{it}\right] + (1 - \pi_t) q(a_{i,t+1})\right\}. \tag{13}$$

Here, π_t denotes the probability of surviving period t conditional on survival in period $t-1$. This survival probability is exogenous and constant across individuals, with $\pi_{100} = 1$. The parameter $\beta \in [0, 1]$ captures time preferences. Expectations $\mathbb{E}[\cdot]$ are taken with respect to future wage and health shocks, conditional on current states and choices. Since the problem does not admit a closed-form solution, we rely on numerical methods to obtain the value function.

6.2 Econometrician's estimation problem

We estimate the model in three steps. In the first two steps we recover parameters that can be identified without solving the full dynamic programming problem, either because they are well established in the literature or because they can be estimated directly from the data under our maintained assumptions. In the third step, we estimate the structural preference parameters that cannot be identified outside the model and therefore require solving the full dynamic programming problem.

In the first step, we set several parameters to values reported in the literature. Specifically, we fix the time discount factor β at 0.99, consistent with the parameter estimates in De Bresser (2024). The interest rate r is set to 1%, reflecting the low interest rate environment in the

Netherlands between 2006 and 2024, the first and last years of our sample period. We set the part-time wage penalty $1-\eta$ to 13%, in line with Russo and Hassink (2008) and Keane and Wasi (2016). Conditional survival probabilities π_t are taken from the 2006 life tables published by the Dutch Royal Actuarial Society.

In the second step, we estimate the parameters governing the exogenous evolution of wages and health status, which we assume to be independent of individual choices. Using the laws of motion in equations (5) and (7), we estimate the wage process with a linear regression and the health process with a binary logit model. The estimated wage and health processes generate wage profiles and health trajectories when simulating life-cycle histories. Estimation details and results are presented in Appendices D.1 and D.2.

In the third step, we estimate the vector of preference parameters $\theta := \{\lambda, \gamma, \psi, \delta, \rho_1, \rho_2\}$ using the MSM. The MSM estimator selects the preference parameters that generate simulated life-cycle decision profiles that best match the empirical moments, as evaluated by a GMM criterion function. Because the optimal weighting matrix performs poorly in small samples, we follow Altonji and Segal (1996) and use a diagonal weighting matrix containing the inverse of the estimated variances of the sample moments. Additional details on the MSM estimator are provided in Appendix D.3.

For each age and birth cohort, the MSM estimator targets the following empirical moments: average assets; pension claiming rates; full-time and part-time employment rates among healthy individuals; employment rates among sick individuals; and the share of individuals claiming pension benefits while working part-time. Appendix D.4 provides further details on the preparation of the asset data used to construct the asset-related moments.

In Section 5, we use a DiD strategy to estimate the reduced-form effects of pension reforms on retirement behavior. The reforms vary across birth cohorts: individuals born in December 1949 are the only cohort eligible for the generous early occupational pension provisions, with eligibility starting at age 55, while those born in January 1950 and January 1953 differ in their SRA. These cohort-specific policy changes provide the exogenous variation needed for the reduced-form analysis.

In the structural analysis, we exploit the same cohort-specific reforms in a different way. Our dynamic life-cycle model is estimated using the MSM, and identification of the preference parameters comes from the behavioral differences induced by the SRA reform. We therefore use data from the January 1950 and January 1953 cohorts, which faced different SRAs but were otherwise subject to the same institutional environment. We construct initial state variables (x_{i,t_0}) and compute empirical moments using only these two cohorts, and the MSM criterion matches these moments to their simulated counterparts.

We reserve the December 1949 cohort for model validation. Validation refers to an out-of-sample test of the model: after estimating the preference parameters using only the SRA reform, we keep these parameters fixed and simulate the model under the early retirement rules that apply to the December 1949 cohort. We then compare the model's predictions to the observed behavior of this cohort. Because the early retirement reform involved substantially larger changes in pension rules and generated stronger behavioral responses, it provides a demanding test of whether the estimated model can replicate behavior under a policy change that was not used for estimation.

As a robustness check, we reverse the roles of the two reforms. We estimate the model using the early retirement reform, using December 1949 and January 1950 cohorts, and validate it using the SRA reform. The resulting parameter estimates, presented in Appendix D.5, are very similar. This separation between estimation and validation ensures that the preference parameters are identified by one policy change while the model's predictive performance is assessed using another.

7 Estimation results and model validation

This section presents the estimates of the structural parameters and evaluates how well the model fits the data.

7.1 Parameter estimates and model fit

Table 4 presents the preference parameter estimates. Although specific to our context and functional-form assumptions, the estimates are broadly consistent with earlier studies. We estimate λ, which determines the marginal utility of consumption, to be approximately -0.364. Given that the elasticity of intertemporal substitution for consumption is defined as $\frac{1}{1-\lambda}$, our estimate implies a consumption EIS of 0.73. This is close to recent evidence for the Netherlands in Marenčák and Nghiem (2025), who report an elasticity of 0.70.

We estimate γ, which determines the marginal utility of leisure, to be -0.066. Given that the elasticity of intertemporal substitution for leisure is defined as $\frac{1}{1-\gamma}$, this estimate corresponds to a leisure EIS of 0.94. A leisure EIS of this magnitude means that individuals do not place a high utility penalty on having uneven amounts of leisure over time. Rogerson and Wallenius (2013) show theoretically that, in a standard life-cycle model with unrestricted hours choice, abrupt retirement is only optimal when individuals are willing to tolerate a highly uneven leisure profile, that is, when they do not mind an abrupt transition from full work to full leisure. In their model, this requires a sufficiently high leisure EIS. Our estimate is therefore consistent with the type of preferences that can rationalize abrupt retirement transitions. In our data, the take-up of partial retirement is indeed limited (Table 2), which is consistent with an environment in which gradual reductions in hours are relatively uncommon. While our estimated leisure EIS suggests that observed retirement behavior is consistent with relatively discrete changes in hours, stated-preference evidence for the Netherlands from Kantarcı et al. (2025) shows that many individuals would prefer gradual retirement in the absence of constraints. Taken together, this suggests that the high leisure EIS implied by our structural estimate may partly reflect features of the observed environment rather than a fundamental preference for abrupt retirement. These features may include limited employer-side flexibility, information frictions around partial retirement, or perceived pension consequences.

The parameter ψ, which scales the weight of leisure in utility relative to consumption, is estimated to be 0.041. The order of magnitude of our estimate also reflects the normalization adopted in the model: leisure l_{it} is set to 0.5 for a healthy full-time worker, while simulated annual consumption c_{it} is approximately 30,000, so the leisure term must be scaled accordingly to have a comparable impact on utility.

The time cost of bad health, δ, is estimated to be about 587 hours per year. This is somewhat larger but still comparable in magnitude to estimates in the literature, which range from 100 to 500 hours (French, 2005; French and Jones, 2011; De Bresser, 2024). However, our definition of bad health only includes severe cases that qualify for DI benefits, which may explain the larger estimate. The estimate implies that the marginal utility of leisure is substantially higher for sick individuals than for healthy ones, and that sickness reduces disposable time by roughly 15% ($587/4,000$).

The relative weight of the bequest motive and its curvature, ρ_1 and ρ_2, are estimated to be 36.045 and 166.647, respectively. While the literature documents substantial heterogeneity in bequest parameters across studies, our estimates are of comparable magnitude to those found in the existing structural literature, which typically finds ρ_1 in the range of 0 to 2,000 and ρ_2 in the range of 200,000 to 500,000 (French, 2005; De Nardi et al., 2010; French and Jones, 2011; De Bresser, 2024; De Nardi et al., 2025).

Table 4: MSM estimates of preference, health, and bequest parameters

Parameter	Estimate
λ	-0.364
	(0.002)
γ	-0.066
	(0.019)
ψ	0.041
	(0.001)
δ	587.174
	(17.044)
ρ_1	36.045
	(1.451)
ρ_2	166.647
	(5.984)

Note: Asymptotic standard errors in parentheses.

Using the structural model estimates, Figures 5 and 6 compare the behavior generated by the model to that observed in the data. The left and right panels present results for the January 1950 and January 1953 cohorts, the two cohorts used in estimation. The model reproduces the targeted empirical moments for labour supply, pension claiming, and asset accumulation remarkably well. It also captures the cross-cohort differences in part-time work: individuals in the 1950 cohort are more likely to choose part-time work without claiming a pension and less likely to combine part-time work with pension benefits, consistent with the empirical patterns.

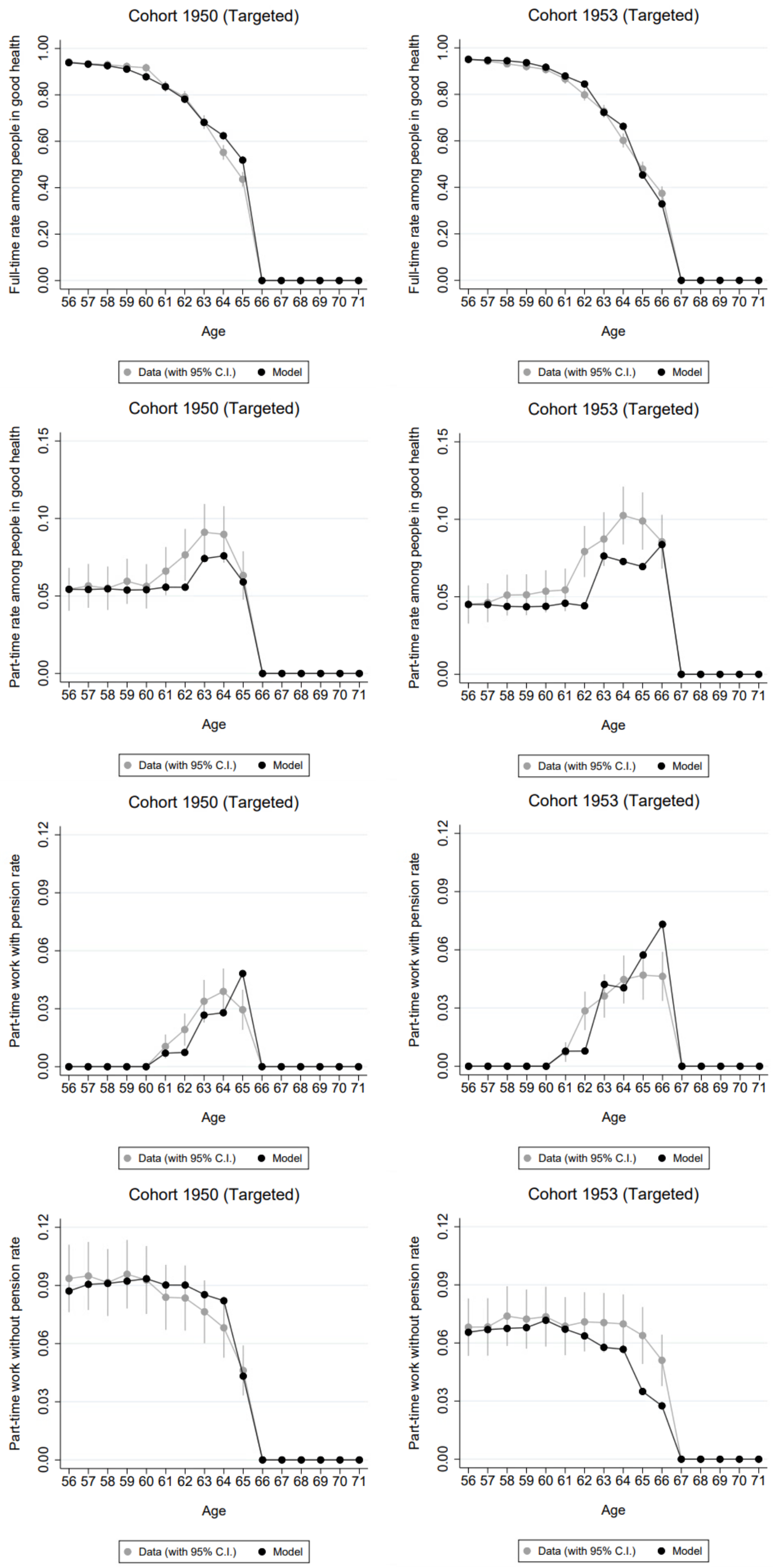

Figure 5: Model fit for the January 1950 and January 1953 estimation cohorts

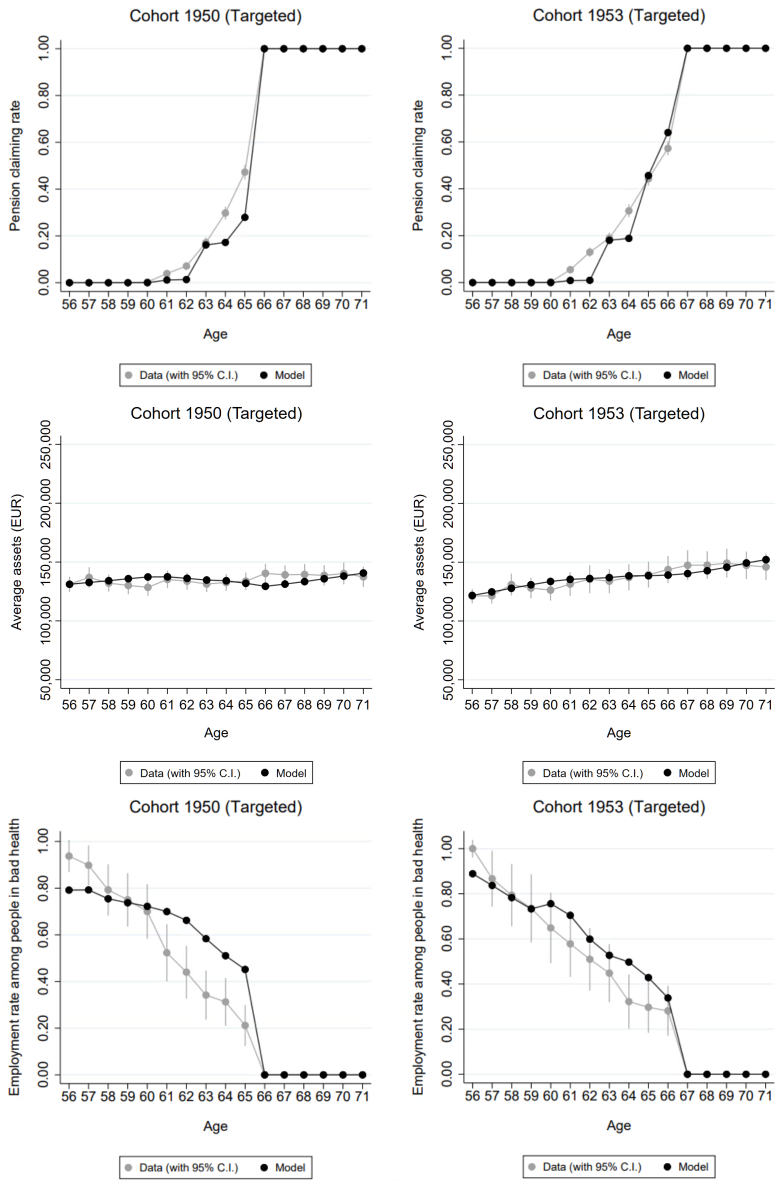

Figure 6: Model fit for the January 1950 and January 1953 estimation cohorts

7.2 Model validation

Recent empirical work integrates exogenous policy-induced variation into structural models, strengthening identification and thereby enhancing the credibility of counterfactual policy simulations (Low and Meghir, 2017; Andrews et al., 2020). This approach typically takes one of two forms: researchers either use reforms to estimate the model by fitting its parameters so that it reproduces the behavioral responses induced by the reforms (French et al., 2022; Low and Pistaferri, 2015; Autor et al., 2019; Best et al., 2020; Low et al., 2020; DellaVigna et al., 2017), or they reserve the reform for out-of-sample validation of the model's counterfactual predictions (Todd and Wolpin, 2006; Attanasio et al., 2012; De Bresser, 2024).

The institutional context shaped by two major pension reforms, combined with rich administrative data, allows us to pursue both approaches simultaneously. We first estimate the structural model using the January 1950 and January 1953 cohorts. We then validate the model by applying the estimates reported in Table 4 to simulate life-cycle profiles for the December

1949 cohort and comparing these simulated trajectories to the observed data. This validation exercise is particularly informative because the December 1949 cohort exhibited markedly different retirement patterns relative to those of the January 1950 and January 1953 cohorts (Figure 1). Evaluating whether the model can reproduce these non-targeted differences provides a stringent test of its external validity and strengthens confidence in its ability to generate credible counterfactual policy simulations.

The results are presented in Figures 7 and 8, which show the simulated and observed life-cycle profiles for the December 1949 cohort, the non-targeted cohort used for validation. The figures show that the model reproduces well the labour supply and pension claiming decisions of this cohort. In particular, the model captures the differences across pension regimes: at all ages, the share of individuals claiming a pension is higher for the 1949 cohort than for the January 1950 and January 1953 cohorts, both in the data and in the simulations, while the share working full time is correspondingly lower.

With respect to partial retirement as the focus of our study, the model also replicates well the differences across cohorts in part-time work at older ages. Figure 9 illustrates this by comparing part-time employment rates between the 1949 and 1950 cohorts in the left panel and between the 1950 and 1953 cohorts in the right panel. In both cases, the simulated outcomes align closely with the observed differences induced by the two policy reforms, providing further evidence that the model captures the impact of institutional variation on retirement behavior.

Having established the model's ability to replicate non-targeted patterns, we now turn to policy simulations that are empirically difficult to observe, predicting behavioral responses under counterfactual regimes.

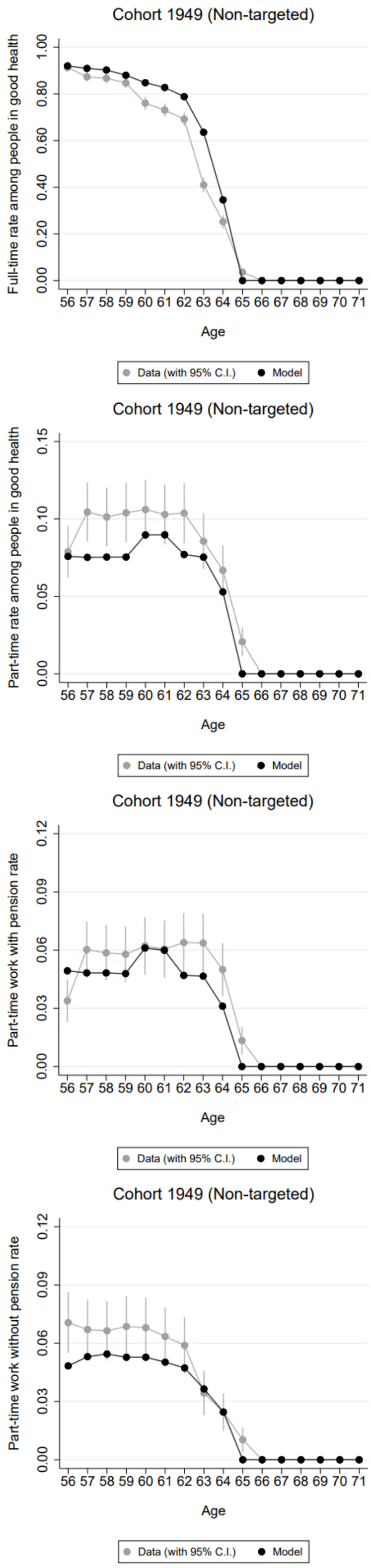

Figure 7: Model fit for the January 1949 out-of-sample cohort

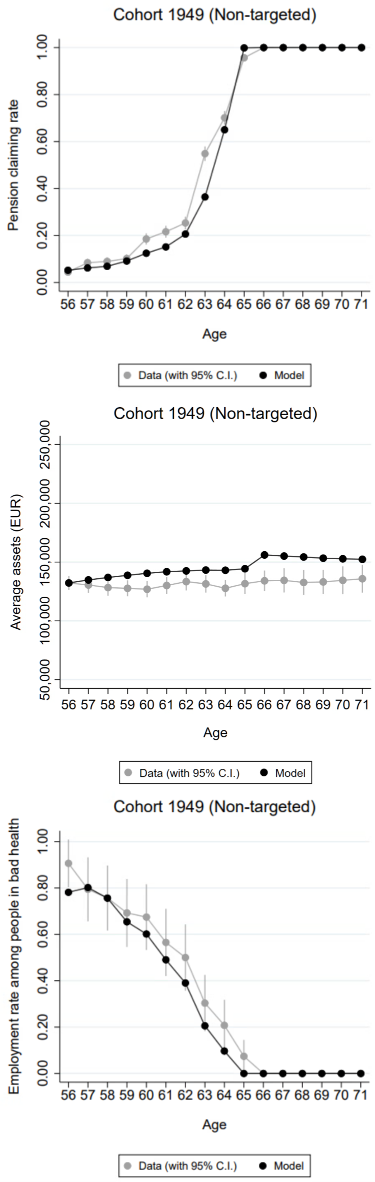

Figure 8: Model fit for the January 1949 out-of-sample cohort

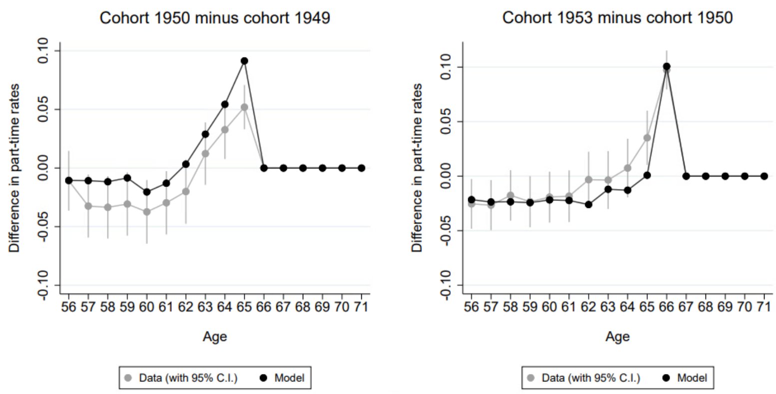

Figure 9: Model fit for part-time work across birth cohorts

8 Policy simulations

The descriptive patterns in Figures 2 and 3, together with the causal evidence on the impact of the early-retirement reform in the left panel of Figure 4, suggest that access to partial pensions, DI benefits, or generous pension provisions allows individuals to supplement part-time earnings with benefit income, thereby facilitating consumption smoothing and making partial retirement financially feasible. Building on this insight, we use the structural model to simulate three policy interventions. While all interventions we simulate may, in principle, enhance the affordability of partial retirement, each operates through a different economic mechanism and reshapes the incentive structure of partial retirement in a distinct way. In the first simulation individuals are permitted to claim partial pension benefits while working part-time. This expands the set of feasible intertemporal allocations of accrued pension rights. This policy facilitates consumption and leisure smoothing but does not increase lifetime income. By contrast, the second and third simulations introduce direct financial incentives for partial retirees through wage and pension-accrual subsidies. Wage subsidies raise income during the years of part-time work, whereas pension-accrual subsidies increase income during the subsequent phase of full retirement.

We conduct each simulation for three cohorts and retain all cohort-specific differences in pension rules generated by the two reforms studied in this paper. For example, the 1953 cohort continues to face a higher SRA than the 1949 and 1950 cohorts. In all simulations, partial retirement is defined as leaving full-time work at the cohort-specific early retirement age, transitioning into part-time work, and subsequently exiting the labour force.

8.1 Access to partial pensions

Since 2006, compulsory occupational pension schemes in the Netherlands have allowed individuals to claim part of their accrued occupational pension rights while working part-time. This option has only recently been adopted in several other countries.[4] To assess its implications, we simulate individual behavior in a setting where individuals can combine part-time wages with partial pensions until their SRA, as in the agents' optimization problem described in Section 6.1, and compare this to a benchmark in which this option is removed.

Figure 10 presents the simulation results. Allowing individuals to claim partial occupational pension rights increases part-time work across all cohorts. For younger cohorts, this effect emerges at later ages. This pattern likely reflects mechanical eligibility differences: only the 1949 cohort can claim occupational pension rights before age 60, and only the 1953 cohort can continue working until age 66 and 4 months (Table 1). At the same time, the effects are stronger for younger cohorts. For the 1953 cohort, for example, access to partial pensions increases part-time employment by roughly 4 percentage points between ages 63 and 66.

Notably, the increase in part-time work is drawn almost equally from reductions in full-time employment and full retirement. This implies that allowing individuals to flexibly combine part-time work with pension benefits facilitates gradual transitions into retirement without reducing overall labour supply. Calculations based on the simulations confirm that the policy has only a negligible effect on hours worked at any given age.

[4] OECD (2025) reports that only one in three surveyed countries place no restrictions on combining wages and partial pensions before the state pension age. Among the recent adopters, Switzerland introduced this option in 2024 and Austria in 2026.

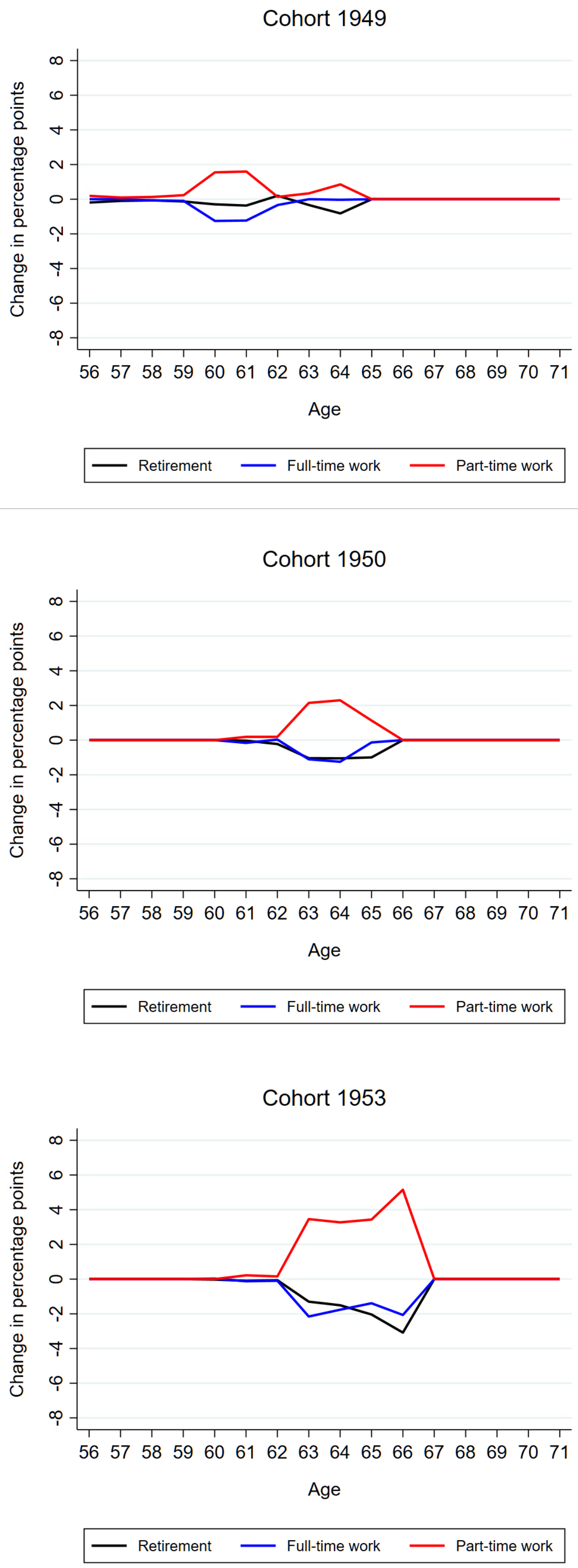

Figure 10: Title.

8.2 Wage subsidies during partial retirement

Since 2006, an increasing number of Dutch collective labor agreements have introduced subsidized partial retirement schemes (Generation Pact). Typically starting at age 60 or 62, depending on the sector, these schemes allow employees to reduce working hours in the years leading up to their SRA, with a less-than-proportional reduction in income and continued pension accrual based on full-time earnings (Section 2). These schemes do not themselves provide access to partial pension rights; such rights can be claimed separately from the occupational pension fund. Sector agreements also differ in how much weekly hours can be reduced and how much they subsidize the salary and often offer multiple options. Here we consider two widely utilized options: employees who work 50% of their former hours earn 60% of their former wage, and employees who work 80% of their former hours earn 90% of their former wage. In both options employees still accrue pension rights over 100% of their original (full-time) wage. We do not allow individuals to access to partial pension rights. We simulate the effect of subsidizing wages, and compare this to a benchmark in which there is no subsidy. In the next section, we examine the effect of subsidizing pension accrual. This allows us to disentangle their respective impacts.

Figure 11 presents the results. Wage subsidies increase part-time employment, but the magnitude of the effect differs substantially across cohorts. For the 1949 cohort, the increase is less than one percentage point, whereas for the 1950 and 1953 cohorts it is considerably larger, reaching between six and eight percentage points. For the 1949 cohort, who had access to generous early-retirement benefits, wage subsidies for part-time work do not meaningfully alter optimal retirement decisions. By contrast, for the 1950 and 1953 cohorts, partial retirement becomes substantially more prevalent.

These sizable increases in part-time employment arise because both full-time work and retirement become less common, shifting individuals into part-time arrangements. As a result, total hours worked remain close to zero for the 1949 cohort but turn negative for the 1950 and 1953 cohorts, declining by roughly -1 to -2% over ages 61 to 66.

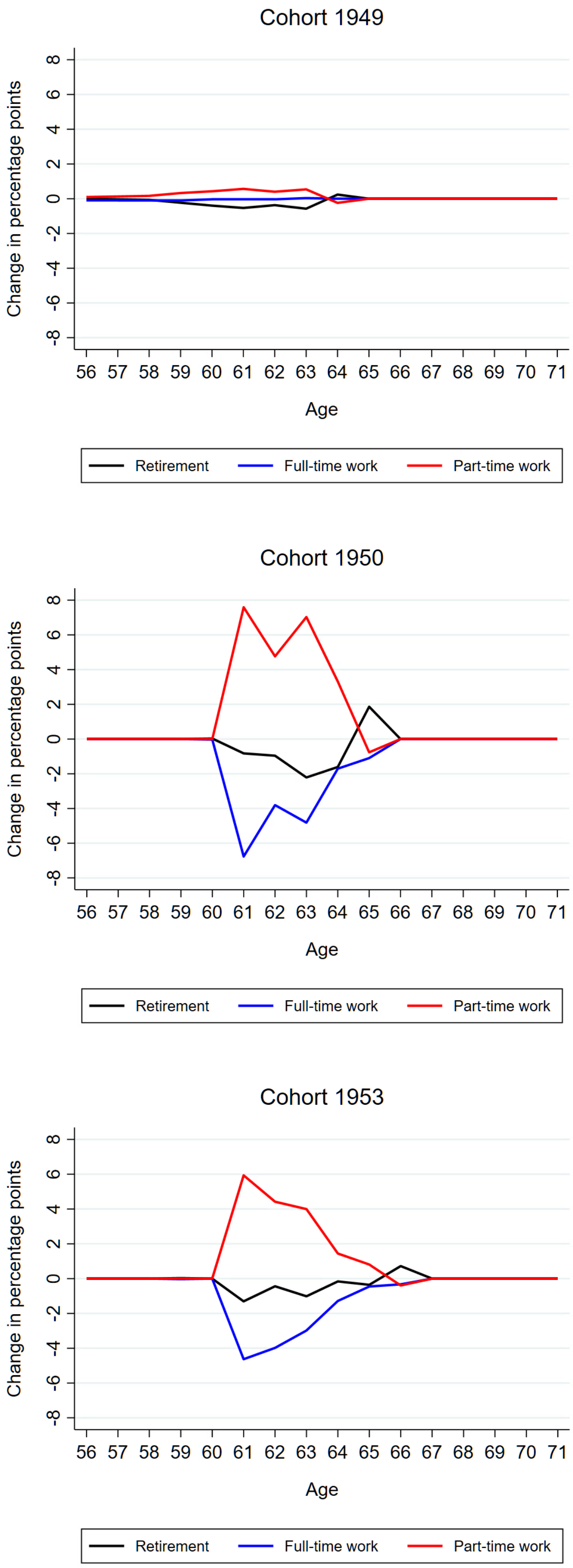

Figure 11: Title.

8.3 Pension-accrual subsidies during partial retirement

The structure of the Generation Pact parallels the phased retirement program for federal employees in the United States, where employees work part-time for proportional pay but continue to accrue pension rights as if working full-time. Here we simulate the effect of subsidizing pension accrual during partial retirement, as in the Generation Pact, and compare this to a benchmark in which there is no subsidy. Figure 12 presents the simulation results. The policy does not meaningfully alter optimal retirement decisions. A likely explanation is that the gain in lifetime income from accruing pension rights on a full-time basis during partial retirement is modest.

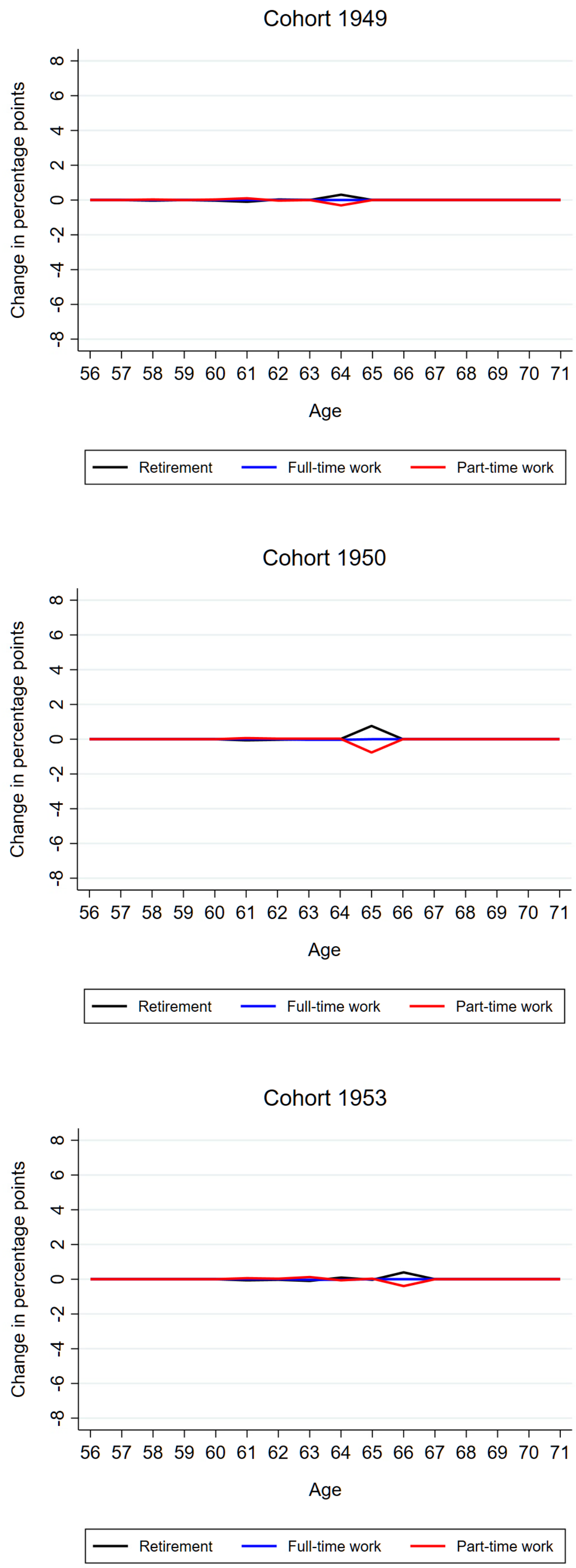

Figure 12: Title.

9 Conclusion

To be completed.

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Online Appendix

A Stylized facts

A.1 Truncated distribution of full-time equivalent

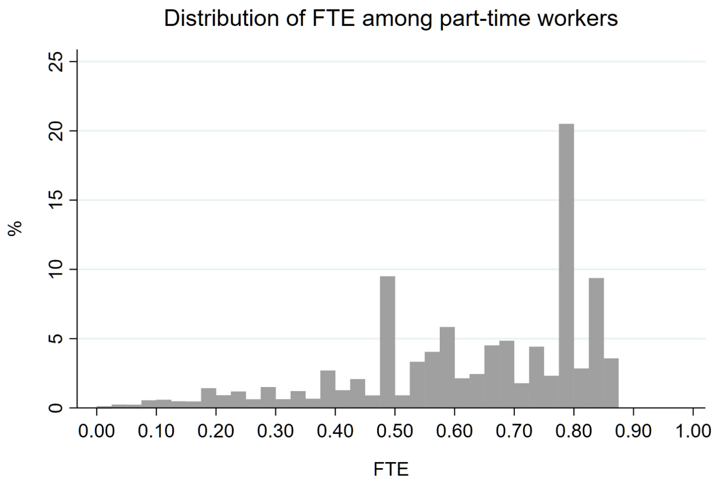

Figure 13: Truncated distribution of full-time equivalent values (FTE < 0.875).

A.2 The fraction of accrued pension rights claimed while working part-time

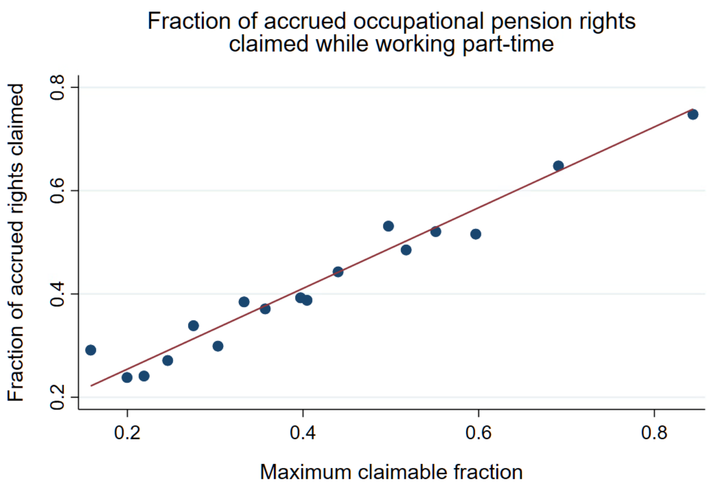

Figure 14: Fraction of accrued occupational pension rights claimed while working part-time.

Figure 14 plots the average fraction of accrued occupational pension rights that individuals claim while working part-time, conditional on claiming any fraction of accrued rights, against the maximum fraction they can claim, given by $1 - \text{FTE}$. The claimed fraction is computed as the ratio of pension rights claimed in the last year of partial retirement to those claimed in the first year of full retirement. The full-time equivalent corresponds to the level of employment in the last year of partial retirement. The figure shows that individuals typically claim the maximum possible amount, which supports our modeling assumption.

A.3 Fraction of individuals claiming accrued occupational pension rights

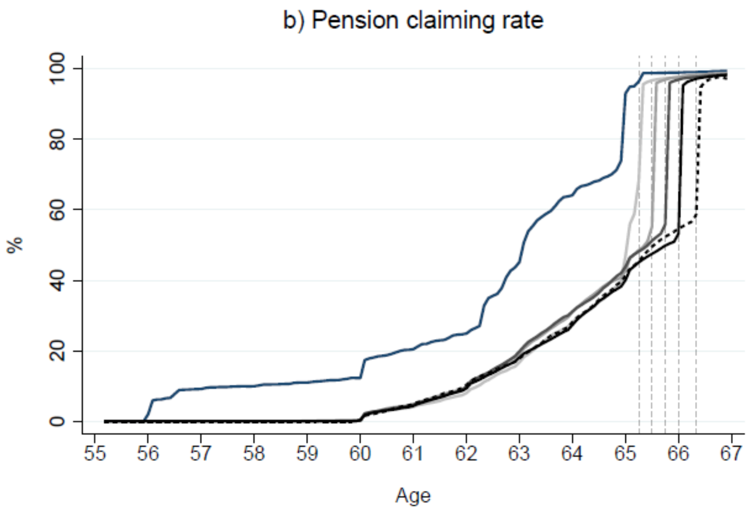

Figure 15: Fraction of individuals claiming accrued occupational pension rights.

Figure 15 plots the fraction of individuals who claim their accrued occupational pension rights. Vertical reference lines indicate the state pension eligibility ages. The figure shows that almost all individuals claim their occupational pension rights as soon as they become eligible for the state pension.

B Robustness to a regression discontinuity approach

In section 5, the DiD estimates of the effects of the early retirement and SRA reforms rely on the assumption that, in the absence of the reforms, the outcome variable would have followed the same age-related trend in the treatment and control groups. We showed that the treatment and control groups exhibit no systematic differences in the outcome during the pre-treatment period. Here we argue that the fact that we find significant effects of the reforms does not depend on the specific identifying assumption we made. We consider an alternative identification strategy that relies on different identifying assumptions, and the results confirm the results based on the DiD method.

B.1 RD model

We exploit the birth-date cut-offs that assigned individuals to different pension eligibility rules as a source of exogenous variation in treatment status. We rely on a sharp RD design to estimate the effect of the two reforms. In particular, the discontinuous jumps at the cut-offs identifies the treatment effect of interest which can be formalized as

$$\lim_{x \downarrow c} \mathbb{E}[Y_i \mid X_i = x] - \lim_{x \uparrow c} \mathbb{E}[Y_i \mid X_i = x] \tag{14}$$

where X_i is the birth date and c a cut-off point. For the early retirement reform, the cut-off is January 1, 1950: individuals born in December 1949 or earlier retained access to the generous early-retirement occupational pensions, whereas those born just after the cut-off were no longer eligible (Table 1). We compare individuals born in December 1949 with those born in January 1950, two adjacent birth cohorts, examining their behavior at the statutory retirement age of 65 years and 3 months.

With respect to the SRA reform, individuals born in January 1950 or later were no longer eligible for the generous early-retirement occupational pensions, and successive birth cohorts within this group became subject to progressively higher SRAs. We compare individuals born in December 1952 with those born in January 1953, two adjacent birth cohorts. We examine their behavior at the statutory retirement age of the treated group, which is 66 years and 4 months.

The treatment effect is estimated using a triangular kernel and an MSE-optimal bandwidth selector (see Calonico et al., 2014). We compute robust standard errors clustered at the individual level to account for within-individual correlation of error terms across calendar months.

The sharp RD design relies on two main assumptions. The first requires a discontinuous jump in treatment status at the cut-off. This condition is satisfied by construction in our setting: all individuals i with $X_i \geq c$ are assigned to the treatment group, while those with $X_i < c$ belong to the control group.

The second assumption requires continuity in potential outcomes as a function of the assignment variable around the cut-off. This implies that, in the absence of the reform, the outcome variable would not exhibit a discontinuous jump at the cut-off. In other words, all other factors affecting the outcome must evolve smoothly at the threshold. Although this assumption cannot be tested directly, one can examine whether relevant covariates exhibit significant changes at the cut-off. Since we compare individuals born only one month apart, we assume that these covariates do not vary meaningfully at the cut-offs.

B.2 Reduced-from estimates

Figure 16 presents the RD plots. Each plot shows local linear fits for an outcome using a symmetric bandwidth of thirty days around the cut-off date. The outcomes are working full-time and working part-time. The left panel corresponds to the early retirement reform, and the right panel to the SRA reform. Vertical lines indicate the birth dates at which different pension rules apply. The plots show clear discontinuities at the cut-off points, in the expected directions. Moreover, the magnitudes of the jumps are consistent with the DiD estimates shown in Figure 4. Overall, both identification strategies provide evidence that the early retirement and SRA reforms significantly altered incentives to work full-time and part-time.

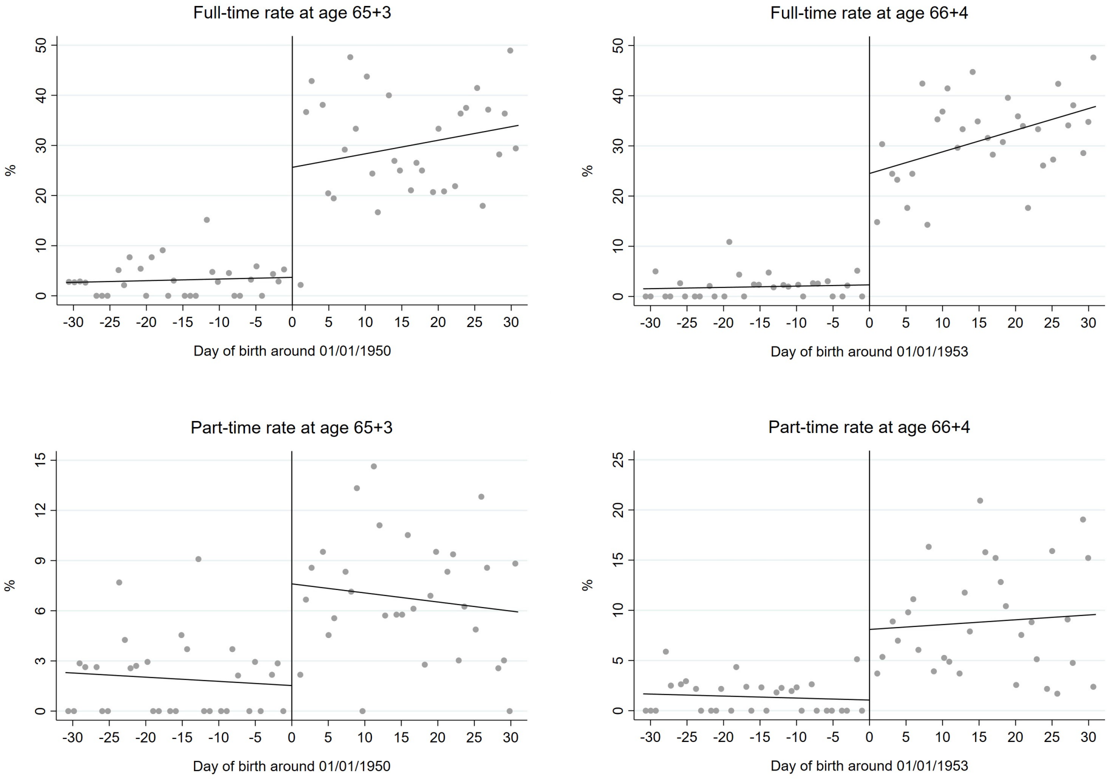

Figure 16: Impact of the early retirement (left panel) and SRA (right panel) reforms.

C Details on the model setup

C.1 Model notation

Table 5: Notation for model variables and feasible sets

Symbol	Description
d_{it}	Vector of decision variables
$\mathcal{D}(x_{it})$	Feasible decision set given state x_{it}
h_{it}	Annual hours of work (decision variable)
$\mathcal{H}$	Baseline choice set for h_{it}
o_{it}	Occupational pension claiming (binary decision)
$\mathcal{O}$	Baseline choice set for o_{it}
c_{it}	Consumption (decision variable)
$\mathcal{C}(h_{it}, o_{it}, x_{it})$	Feasible consumption set given (h_{it}, o_{it}, x_{it})
x_{it}	Vector of state variables
t	Age in years (state variable)
w_{it}	Annual full-time wage (state variable)
p_{it}	Accrued occupational pension rights (state variable)
$g(d_{it}, x_{it})$	Occupational pension actuarial adjustment factor
e_{it}	Occupational pension annuity entitlement
g_{it}	State pension annuity entitlement (AOW)
$g(k_i)$	State pension offset
t^g	State pension eligibility age
s_{it}	Retirement status (state variable)
k_i	Birth cohort (state variable)
a_{it}	Assets (state variable)
$\mathcal{A}(x_{it})$	Feasible asset set given state x_{it}
r	Constant net return on assets
m_{it}	Health status (state variable)
l_{it}	Leisure as a function of h_{it} and m_{it}
q_{it}	Bequest motive as function of a_{it}
y_{it}	Earnings from wages
f_{it}	Full-time equivalence
η	Part-time wage multiplier
b_{it}	Disability insurance benefit
π_t	Conditional survival probability in period t
I_{it}	Taxable income
T_{it}	Income tax liability
A_{it}	Asset tax liability
L_{it}	Labor tax credit
N_{it}	Net income

Table 6: Notation for model parameters

Symbol	Description
λ	Curvature of utility with respect to consumption c_{it}
γ	Curvature of utility with respect to leisure l_{it}
ψ	Relative weight of leisure in utility
δ	Health time penalty parameter
ρ_1	Bequest motive strength parameter
ρ_2	Bequest shift parameter
β	Time preference parameter
$z(k_i)$	Occupational pension accrual rate parameter
α	Intercept in wage process
ϕ	Autoregressive coefficient for wage process
ϵ_{it}	Wage shock (innovation term)
$\sigma_{\epsilon_{it}}$	Standard deviation of wage shock
μ_0	Baseline health risk parameter
μ_1	Age effect on health risk
μ_2	Health persistence parameter
κ^j	Contribution rate for scheme $j \in \{\text{WW}, \text{ZVW}, \text{VV}, \text{ABP}\}$

C.2 Social insurance and tax schedules

In our model, we use the institutional rules and parameter values that were in force in 2006. We take 2006 as the reference year because this is the first year in which we observe all variables needed to initialize the agents' decision problem (Section 3). Moreover, although later years may feature different rules or updated nominal amounts due to routine indexation, we keep the 2006 schedules fixed. Allowing year-specific rules would require embedding time-varying institutional rules and parameter values directly into the dynamic programming problem, substantially increasing the complexity of both the model and its estimation. For example, in 2006 employees paid unemployment insurance (WW) contributions, while employers paid their own WW contributions separately. As part of payroll tax reforms implemented in 2009, the employee WW contribution was abolished and WW financing has since been borne entirely by employers. Routine inflation adjustments do not affect our modeling because we convert all nominal amounts into 2006 euros using the consumer price index published by Statistics Netherlands.

Social security contributions

Social security contributions are employee-insurance premiums that finance earnings-related social insurance schemes. They are tied to employment and are typically paid by employers, and historically partly by employees. Until 2006, employees contributed to the unemployment insurance scheme under the Dutch Unemployment Act (Werkloosheidswet, WW), with contributions assessed on earnings according to

$$\kappa_{it}^{WW} = \begin{cases} 0, & y_{it} + b_{it} < 15{,}562, \\ 0.058\left(y_{it} + b_{it} - 15{,}562\right), & 15{,}562 \leq y_{it} + b_{it} < 44{,}800, \\ 0.058\left(44{,}800 - 15{,}562\right), & y_{it} + b_{it} \geq 44{,}800, \end{cases}$$

where y_{it} denotes annual gross earnings and b_{it} denotes DI benefits, as defined in Section 6.

Employees are also required to contribute to the universal public health insurance scheme under the Dutch Health Insurance Act (Zorgverzekeringswet, ZVW). The employee contribution is given by

$$\kappa_{it}^{ZVW} = \begin{cases} 0.0125\,(y_{it} + b_{it}) + 399, & y_{it} + b_{it} < 30{,}320, \\ 0.0125 \cdot 30{,}320 + 399, & 30{,}320 \leq y_{it} + b_{it} < 33{,}514, \\ 0, & y_{it} + b_{it} \geq 33{,}514. \end{cases}$$

Taxable income

Social security contributions to WW and ZVW are deducted from gross income to obtain taxable income:

$$I_{it} = y_{it} + b_{it} + e_{it} + g_{it} - \kappa_{it}^{WW} - \kappa_{it}^{ZVW},$$

where g_{it} denotes state pension annuity entitlement.

National insurance contributions

National insurance contributions (premies volksverzekeringen, VV) are universal social insurance contributions that finance population-wide programs that are not tied to employment. Every resident pays these contributions through the income tax system. They cover the state pension (AOW), surviving dependants' benefits (ANW), and long-term care (WLZ). VV contributions are assessed on taxable income in the lower part of the income distribution and are paid by individuals rather than employers. They apply only to the first two taxable income brackets and depend on whether the individual has reached the statutory state pension age t^g. Formally, the liability is defined as

$$\kappa_{it}^{VV} = \begin{cases} 0.324\, I_{it}, & I_{it} < 30{,}371 \text{ and } t < t^g, \\ 0.324 \cdot 30{,}371, & I_{it} \geq 30{,}371 \text{ and } t < t^g, \\ 0.145\, I_{it}, & I_{it} < 30{,}371 \text{ and } t \geq t^g, \\ 0.145 \cdot 30{,}371, & I_{it} \geq 30{,}371 \text{ and } t \geq t^g. \end{cases}$$

Income tax

Income tax is levied at the individual level, meaning that each person's earnings are taxed separately rather than on a household basis (OECD, 2004). The tax base is taxable income I_{it}, which includes DI benefits. The income tax liability is given by

$$T_{it} = \begin{cases} 0.01\, I_{it}, & I_{it} < 16{,}721, \\ 0.01 \cdot 16{,}721 + 0.0795\,(I_{it} - 16{,}721), & 16{,}721 \leq I_{it} < 30{,}371, \\ 0.01 \cdot 16{,}721 + 0.0795\,(30{,}371 - 16{,}721) \\ \quad +0.42\,(I_{it} - 30{,}371), & 30{,}371 \leq I_{it} < 52{,}072, \\ 0.01 \cdot 16{,}721 + 0.0795\,(30{,}371 - 16{,}721) \\ \quad +0.42\,(52{,}072 - 30{,}371) \\ \quad +0.52\,(I_{it} - 52{,}072), & I_{it} \geq 52{,}072. \end{cases}$$

Asset tax

Prior to 2017, the Dutch income tax system included a levy on net assets. Taxpayers were assumed to earn a fixed return of 4% on net assets above the statutory threshold, which was then taxed at a rate of 30%. This implied an effective tax burden of 1.2% on assets exceeding €39,568. Formally, the liability is specified as

$$A_{it} = \begin{cases} 0, & a_{it} < 39{,}568, \\ 0.012\,(a_{it} - 39{,}568), & a_{it} \geq 39{,}568, \end{cases}$$

where a_{it} denotes the asset balance of individual i in period t.

Tax credits

Taxpayers are entitled to two major tax credits. First, the general tax credit (algemene heffingskorting) applies and amounts to €1,876. It is deducted directly from the calculated income tax liability. Second, the labour tax credit (arbeidskorting) is deducted from income tax and depends on the level of annual earnings y_{it}, according to

$$L_{it} = \begin{cases} 0.01753\, y_{it}, & y_{it} < 8{,}328, \\ 0.01753 \cdot 8{,}328 \;+\; 0.11213\,(y_{it} - 8{,}328), & 8{,}328 \le y_{it} < 18{,}147, \\ 0.01753 \cdot 8{,}328 \;+\; 0.11213\,(18{,}147 - 8{,}328), & y_{it} \ge 18{,}147. \end{cases}$$

Occupational pension contributions

Employees contribute to the occupational pension fund ABP on gross wages above the statutory state pension offset $g(k_i)$. The individual contribution is defined as

$$\kappa_{it}^{ABP} = \begin{cases} 0, & w_{it} < 9{,}839, \\ 0.0636\, f_{it}\,(w_{it} - 9{,}839), & w_{it} \ge 9{,}839. \end{cases}$$

Income after contributions and taxes

Net income is given by

$$N_{it} = y_{it} + b_{it} + e_{it} + g_{it} - \kappa_{it}^{WW} - \kappa_{it}^{ZVW} - \kappa_{it}^{VV} - \kappa_{it}^{ABP} - T_{it} - W_{it} + 1,876 + L_{it}$$

D Details on the estimation of the dynamic optimization model

Here we provide additional details on the estimation of the structural model. As with the social insurance and tax schedules discussed in Section C.2, we rely on the institutional rules and parameter values that were in force in 2006 and express all monetary amounts in 2006 prices.

D.1 Estimation of the wage process

Equation (5) presents the assumed wage process. Each period of the life-cycle model corresponds to an age, and therefore we use annual wage observations to estimate the process. Specifically, we use the wage measured in the individual's birth month. Since wages are set by collective labour agreements and do not vary across birth cohorts in terms of wage-setting rules, we estimate the wage process by pooling birth cohorts. As in our DiD analysis in Section 5, we consider three cohorts: those born in December 1949, January 1950, and January 1953. We do not adjust for the fact that wages are observed only for employed individuals, as the same wage scale applies to all workers regardless of employment status. However, we restrict the estimation sample to observations corresponding to full-time work to avoid any contamination arising from wage changes associated with transitions into part-time employment. We estimate the parameters of the linear wage regression in equation (5) using ordinary least squares. Table 7 presents the coefficient estimates. The autoregressive parameter ϕ is close to one, consistent with the estimate in De Bresser (2024). The variance of the error term ϵ_{it} is estimated to be 0.005.

Table 7: Linear regression model explaining the wage process

Parameter	Estimate
α	0.28***
	(0.04)
ϕ	0.97***
	(0.00)
N = 33,698	

Standard errors (in parentheses) are clustered at the individual level.

D.2 Estimation of the health process

Equation (7) presents the assumed health status process. The outcome is a binary indicator of bad health. In our life-cycle model, bad health implies receiving DI benefits. We therefore estimate the health process using information from Statistics Netherlands on DI recipiency. Since disability insurance coverage extends only until the SRA, we use observations up to age 65 for the 1949 and 1950 cohorts and up to age 66 for the 1953 cohort (Table 1). As with wages, we use annual observations from all three birth cohorts. We estimate the parameters of the binary logit model in equation (7) using maximum likelihood. Table 8 presents the estimation results.

Table 8: Binary logit model explaining the health process

Parameter	Estimate
μ_0	-5.42^{***}
	(0.16)
μ_1	0.01
	(0.02)
μ_2	10.29^{***}
	(0.27)
N = 43,647	

Standard errors (in parentheses) are clustered at the individual level.

D.3 MSM estimator

We describe the MSM estimator following French and Jones (2011). The objective of MSM estimation is to find the preference vector that generates simulated life-cycle decision profiles that best match their empirical counterparts, as measured by a GMM-style criterion function. The estimator solves

$$\hat{\theta} = \arg\min_{\theta} \varphi(\theta, X)^\top \widehat{W} \varphi(\theta, X),$$

where θ is an $l \times 1$ vector of unknown parameters. The function $\varphi(\cdot)$ denotes the $k \times 1$ vector of moment conditions, with the k-th element defined as $m_k^d(x) - m_k^s(\theta)$, where m_k^d is the moment computed from the data and $m_k^s(\theta)$ is the corresponding moment generated by the model simulation. The matrix $\widehat{W}$ is a $k \times k$ weighting matrix.

Although the optimal weighting matrix is asymptotically efficient, it can perform poorly in finite samples (see, e.g., Altonji and Segal, 1996). For this reason, we use a diagonal weighting matrix whose entries are the inverses of the estimated variances of the empirical moments. For example, the first diagonal element is $\widehat{W}_{1,1} = [\widehat{\mathrm{Var}}(m_1^d)]^{-1}$.

Under the regularity conditions (Pakes and Pollard, 1989; Duffie and Singleton, 1993), the MSM estimator $\hat{\theta}$ is both consistent and asymptotically normally distributed,

$$\sqrt{n}(\hat{\theta} - \theta_0) \ \to_d \ N(0, V),$$

with asymptotic variance–covariance matrix

$$V = \left(1 + \frac{1}{N_{sim}}\right) (D^\top W D)^{-1} D^\top W S W D (D^\top W D)^{-1}.$$

We use three simulation draws per individual in the estimation procedure.[5] The matrix S is the $k \times k$ variance–covariance matrix of the empirical moments, and D is the $k \times l$ Jacobian of the moment vector evaluated at the MSM estimate $\hat{\theta}$,

$$D = \left.\frac{\partial \varphi(\theta, X)}{\partial \theta^\top}\right|_{\theta = \hat{\theta}}.$$

[5]Since the estimator is consistent for a fixed number of simulations (Adda and Cooper, 2003), and because we are not primarily concerned with inference on the parameter estimates, we simulate each individual only three times to reduce computational burden.

We compute D by numerical approximation and estimate S using the bootstrap. Specifically, we use 500 bootstrap samples drawn with replacement, following De Bresser (2024).

D.4 Asset data preparation

As discussed in Section 6.2, we use the MSM to estimate preferences. The estimator targets empirical moments related to labour supply, pension claiming, and assets for each cohort and age. To construct the asset profiles used in these moments, we perform several adjustments to the raw administrative data.

Since the model features annual decision-making, we match annual life-cycle profiles. Labour supply and pension claiming are measured annually on birthdays. Asset data, however, are obtained from the administrative records of Statistics Netherlands and are observed only on January 1 each year. Therefore, for each individual, we use the asset observation closest to their birthday to construct average asset holdings by age. Administrative asset data are recorded at the household level. Therefore, for married men, we divide reported amounts by the square root of two, following the OECD square-root equivalence scale (OECD, 2018).

Next, we deflate all asset values using the Consumer Price Index published by Statistics Netherlands and express monetary amounts in 2006 euros, consistent with the baseline year used for wages. Finally, business cycle and financial market fluctuations may differentially affect assets across cohorts, while our model does not capture these features. To address this, we net out year effects using a regression approach. Specifically, we estimate a model on a larger panel containing all available cohorts from 1919 to 1956, regressing assets on a full set of age and calendar-year dummies, and subtract the estimated year effects from observed assets.

The resulting adjusted data are used to construct both the asset-related moments (average assets at each age, separately by cohort) and the initial asset holdings at the start of the model (a_{i,t_0}).

D.5 Robustness to reversing the roles of pension reforms used for estimation and validation

In Section 7.1, we exploited the SRA reform in 2011 to estimate the structural model parameters, and the early retirement reform in 2006 to validate these estimates. That is, our method of simulated moments estimates were obtained by selecting the life-cycle decision profiles of the 1950 and 1953 cohorts that best match the empirical moments, exploiting the differences in retirement ages induced by the SRA reform. For out-of-sample validation, we assessed how well the estimated model reproduces the observed retirement behavior of the 1949 birth cohort. We selected this cohort because the changes in pension rules and their behavioral effects were more pronounced under the early-retirement reform, providing a more demanding test of the model's ability to replicate non-targeted pension regimes.

Here we analyze how the model estimates change when we reverse the roles of the two reforms, that is, when we target the 1949 and 1950 cohorts for estimation.[6] Table 9 reports the parameter estimates which are very similar to baseline estimates in Table 4. Consequently, the model fit is nearly identical to the baseline for all three cohorts (results available upon request). Taken together, these findings do not indicate meaningful misspecification.

[6] The number of targeted moments increases to 120, up from 112. We now have 65 moments for the 1949 cohort, 55 for 1950, and 57 for 1953. This change arises because: (i) savings for the 1949 cohort are observed from ages 56 to 71, whereas for the 1953 cohort they are observed only from 56 to 68 (+3 moments); (ii) the 1949 cohort can start claiming pensions five years earlier than the 1953 cohort, generating five additional moments for claiming and five for partial retirement (+10 moments); and (iii) the 1949 cohort can work one fewer year than the 1953 cohort, reducing the number of moments for full-time work, part-time work, work while sick,

Table 9: MSM estimates of preference, health, and bequest parameters under alternative reform targets

Parameter	Estimate
λ	-0.364
	(0.001)
γ	-0.066
	(0.009)
ψ	0.042
	(0.000)
δ	757.732
	(33.573)
ρ_1	31.072
	(0.955)
ρ_2	138.390
	(901.584)

Notes: 1. Baseline MSM estimates (Section 7.1) are obtained by targeting cohorts 1950 and 1953, corresponding to the SRA reform. Robustness estimates target cohorts 1949 and 1950, corresponding to the early retirement reform. 2. Asymptotic standard errors in parentheses.

claiming, and partial retirement (-5 moments).